MHS MIU / Users Guide

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| | DPC | | | Sheet 1 of 129 |

## TABLE OF CONTENTS

## LIST OF ILLUSTRATIONS



## LIST OF TABLES

# INTRODUCTION

## 1.1. Purpose

This document is a users' guide to perform specific commanding and telemetry interpretation of the Microwave Humidity Sensor (MHS) Instrument and MHS Interface Unit (MIU) Box for the NOAA-N/N' Spacecraft.

## 1.2. Scope

This document describes both the MIU and MHS Software Commands and Telemetry, for the NOAA-NN' spacecraft commanding and telemetry systems as used in the Advanced TIROS-N Aerospace Ground Equipment (ATNAGE) test environment. A description of the MIU and MHS commands and telemetry are presented, along with the instructions for their use. Ground commands to the MIU/MHS in this document are limited to those issued to the spacecraft by the Advanced TIROS-N Aerospace Ground Equipment (ATNAGE).

## 1.3. Interfacing Overview

The Microwave Humidity Sounder (MHS) instrument only interfaces to the MIU box. The MIU interfaces to the rest of the NOAA-N/N' spacecraft through the TIROS Command and Control Subsystem (CCS), the TIROS Data Handling Subsystem (DHS) and the TIROS Electrical Power Subsystem (EPS). The EPS portion interfacing to the MIU is the Power Subsystem Electronics (PSE) consisting of the 28v Bus Main, Pulse Load, and Survival Buses. All power is distributed to the MHS through the MIU. The AMSU Information Processor (AIP), the Cross-Strapping Unit (XSU) and the TIROS Information Processor (TIP) boxes comprise the DHS part, while the Control Interface Unit (CIU) is the CCS interface portion to the MIU unit. All of these boxes utilize heritage bus architecture interfaces to the MIU while the MIU implements a MIL-STD-1553B redundant interface to the MHS instrument. A single 1553 bus is used for commanding (CMD), housekeeping (HK) telemetry and for science (SCI) data telemetry packets between the MHS and the MIU. However, the MIU, being the bus controller, determines whether the primary or redundant 1553 bus is utilized. Other than the 1553 bus, there is no redundancy in the MIU. The MHS is redundant internally, having both A and B sides to its electronics. The MIU supplies telemetry (MHS and MIU) to the ground during all operational modes. It also provides MHS survival temperature telemetry to the TIP even when the MHS and MIU are not powered.

## 2. APPLICABLE DOCUMENTS

### 2.1. Lockheed Martin Documents

| | | |
|---|---|---|
| [1] | 8575373 | NOAA – N Command List |
| [2] | 8575374 | NOAA – N Telemetry List |
| [3] | PS-FWD20057860 | MIU Firmware Design Document. |
| [4] | PS-FWR20057860 | MIU Firmware Requirements Document |
| [5] | PS-20057860 | Performance Specification of MHS Interface Unit (MIU) |
| [6] | IS-20046415 | Unique Instrument Interface Specification for the Microwave Humidity Sounder (MHS) |
| [7] | PS-3267403 | Performance Specification AMSU Information Processor (AIP) |
| [8] | PS-2284374 | Performance Specification TIROS Information Processor (TIP) |
| [9] | ML-OPR3282757 | ATNAGE / NAGE Operator Manual |

### 2.2. Instrument Vendor Documents

| | | |
|---|---|---|
| [1] | MHS-TN-JA063-MMP | Microwave Humidity Sounder (MHS) TM-TC and Science Data Format Directory |
| [2] | MHS-OM-JA215-MMP | Microwave Humidity Sounder (MHS) Flight Operations Manual |

### 2.3. Government Reference Documents

| | |
|---|---|
| [1] MIL-STD-1750A | 16-bit Computer Instruction Set Architecture |
| [2] MIL-STD-1815A | Ada Programming Language (1983) |
| [3] MIL-STD-1553B | Aircraft Internal Command/Response Multiplex Data Bus |
| [4] CCSDS 701.0-P-1 | Advanced Orbiting Systems, Networks and Data Links |
| [5] GSFC-S-480-72 | Command/Telemetry Bus General Specification for the NOAA O, P, Q Polar Orbiting Environmental Satellites and EUMETSAT Polar Satellite Systems. |
| [6] GSFC-S-480-73 | Low Rate Data Bus General Specification for the NOAA O, P, Q Polar Orbiting Environmental Satellites and EUMETSAT Polar Satellite Systems. |

## 3. MIU COMMAND TYPES AND FORMATS

Since the only command interface to the MHS instrument is via the MIU, the MIU must handle both MIU and MHS commands. When the MIU receives discrete pulse or discrete level commands from the CIU, they are validated and executed immediately for both MIU and MHS units. When serial commands are received from the CIU, they are first validated and interpreted to determine whether they are for the MIU or the MHS. MIU commands are executed immediately, while MHS commands are reformatted into data packets and then sent onward to the MHS instrument via the 1553 bus. The MIU 1553 Bus Controller software schedules the command packets to the MHS within its 2.67 second window.

Figure 1 below illustrates the roles of the MIU software. The MIU software provides the following capabilities:

1. Accept commands from the CIU to switch MIU operating modes and/or alter MIU parameters.
2. Accept commands from the CIU, reformat them into packets and forward them to the MHS.
3. Utilize the AIP interface to telemeter MHS science data and MIU status.
4. Utilize the TIP interface to telemeter MHS housekeeping data and MIU status.
5. Serve as MIL-STD-1553B bus controller and gather MHS science data (in packet format).
6. Serve as MIL-STD-1553B bus controller and gather MHS housekeeping data (in packet format).
7. Monitor and handle various levels of MIU errors (processor, program, etc.)
8. Manage MIU memory loads, dumps and diagnostics.
9. Generate MIU telemetry data indicating internal MIU status.
10. Manage MHS memory dump operations via 1553B.
11. Manage MHS self-testing (initiate test and gather results via the 1553B)

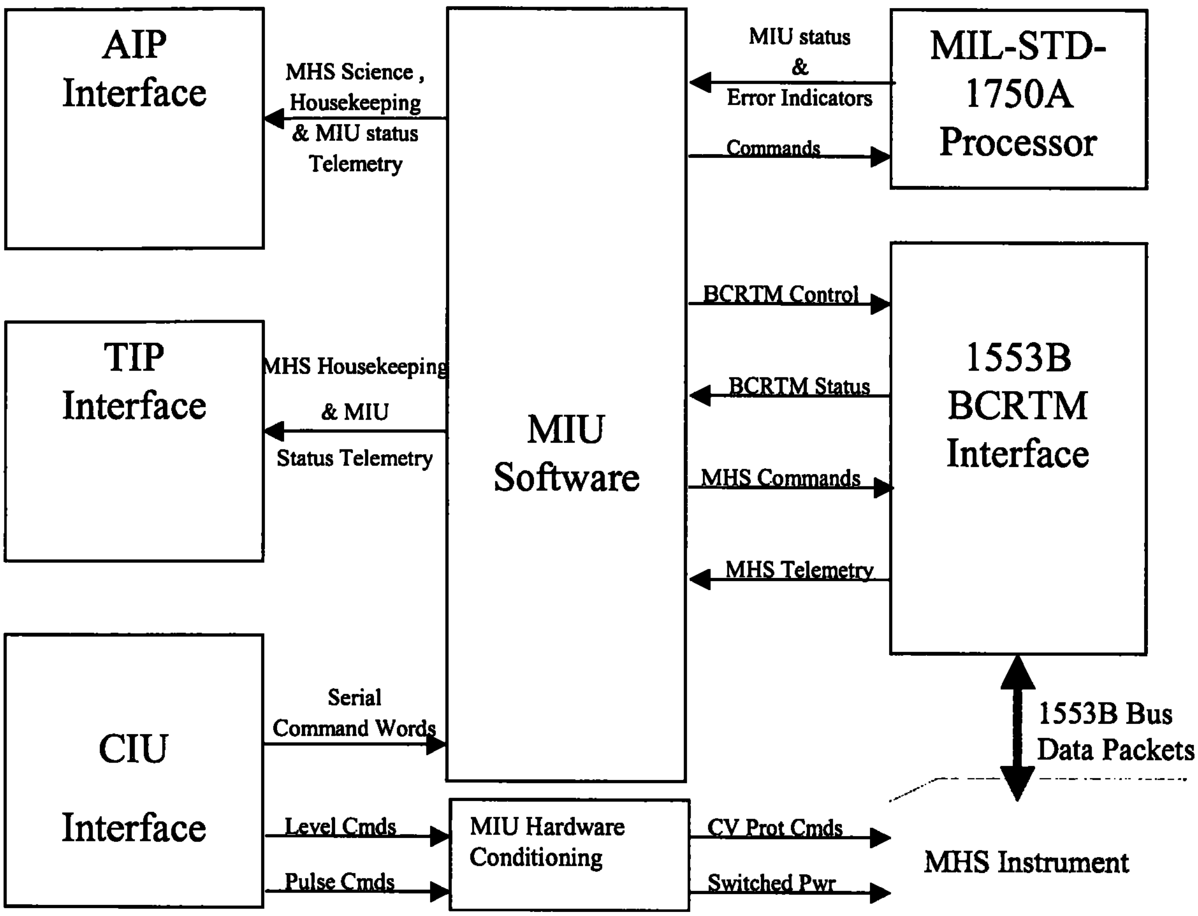



**Figure 1 MIU Software Interface Block Diagram**

### 3.1. General MIU/MHS Commanding Sequence

The following is a brief description of the ATNAGE system commanding of the MIU and MHS units. Commands are stored in the database and referenced by a mnemonic where the ATNAGE will use that database information to retrieve commands or construct commands with appropriate options or parameters. ATNAGE mnemonics will be used to describe the commanding of the MIU/MHS throughout this document, but a more detailed description is contained in the ATNAGE Operator Manual, ML-OPR3282757. There are three general types of MIU/MHS commands:

1) The Discrete Pulse (DP) commands which typically perform power on/off functions where relays are latched.
2) The Discrete Level (DL), where a steady logic state determines enabling or disabling of functions.
3) The Serial Command (SC), where a command or string of commands are sent from the flight spacecraft computer bit by bit in sequence. For the MIU/MHS serial commands are sent from the MIUBUF in the flight software in the CPU, encased in a special transmission "wrapper" format (type 2) and then passes through the CIU to the MIU for processing.

The commands in the ATNAGE database that are prefixed with MH and MI are "type 2" or "883B" special handling commands and therefore are not interpreted by the CPU Flight Software. To send these type commands the ATNAGE directive "*.XM U*" is used which tells the Bus Main software that only preliminary checking needs to be done prior to shipping the command off to the ATNAGE Bus Command Software. The MI_ XXXXX or MH_ XXX mnemonic is checked against an internal list of valid MIU and MHS mnemonics and the number of data words and their types and ranges are determined. Once the correct number of data words and the values are in the correct ranges, the Bus Main software assembles a command packet, same as for all other spacecraft commands, however this packet is identified as containing a command that requires special handling. This packet is sent to the ATNAGE Bus Command software via the DG Interprocess Communication facility (IPC). The Bus Command software receives this command packet on its IPC queue and based on its special handling identifier in the packet header assembles an uplink block as depicted in Figure 2 below. There are two stages of assembly in creating this uplink block.

| Bit: | 0 | 15 | |
|---|---|---|---|
| Checksum | Checksum | | |
| (0..7) | CSN | Reserved | (8..15) |
| (0..5) | Dest. ID | Length | (6..15) |
| | OPCODE (MIU) or Data (MHS) | | Length |
| | Data | | |
| | Data | | |
| | • • • | | |
| | Data | | |
| | | | |

Dest. ID 0=MIU 1=MHS
Length n= 0-1024 for Bootstrap Commands or
= 0-128 for Flight Commands

**Figure 2 MIU/MHS Command Uplink Block**

The first consists of creating an MIU Uplink block, which contains the raw data received from the Bus Main software and information for the MIU as to what to do with this raw data when it gets it. A checksum is calculated on the raw data and is added to the MIU Uplink Block as is a length field that identifies the length of the raw data. Each uplink block is given a sequential count or Command Sequence Number (CSN), which the MIU echoes back in telemetry and it uses to refer to each command it receives.

The ATNAGE Bus Command software then sends an MHSQI (MIUBUF Queue Inhibit.) prior to uploading this Standard Controls Processor (SCP) Load Block. This prevents the Flight Software from trying to transfer a partially loaded data block that does not equal the command length specified.

The second step in uplink packaging is to create a Spacecraft Processor (SCP) load block. The Flight Software does not interpret nor operate upon any of the individual MI XXXXX and MH XXX commands, it just ignores it as raw data. The flight software does interpret the 883B opcode and as a result, loads " n" words of data into the MIUBUF buffer in preparation to transfer serially out to the CIU. The Flight Software packaging includes the 883B opcode for MIU commands and a flight software checksum. For MHS commands, where the "Dest. ID=1", the first MHS data word replaces the MIU OPCODE word and the entire block of words will be passed through to the MIU as MHS data transfers.

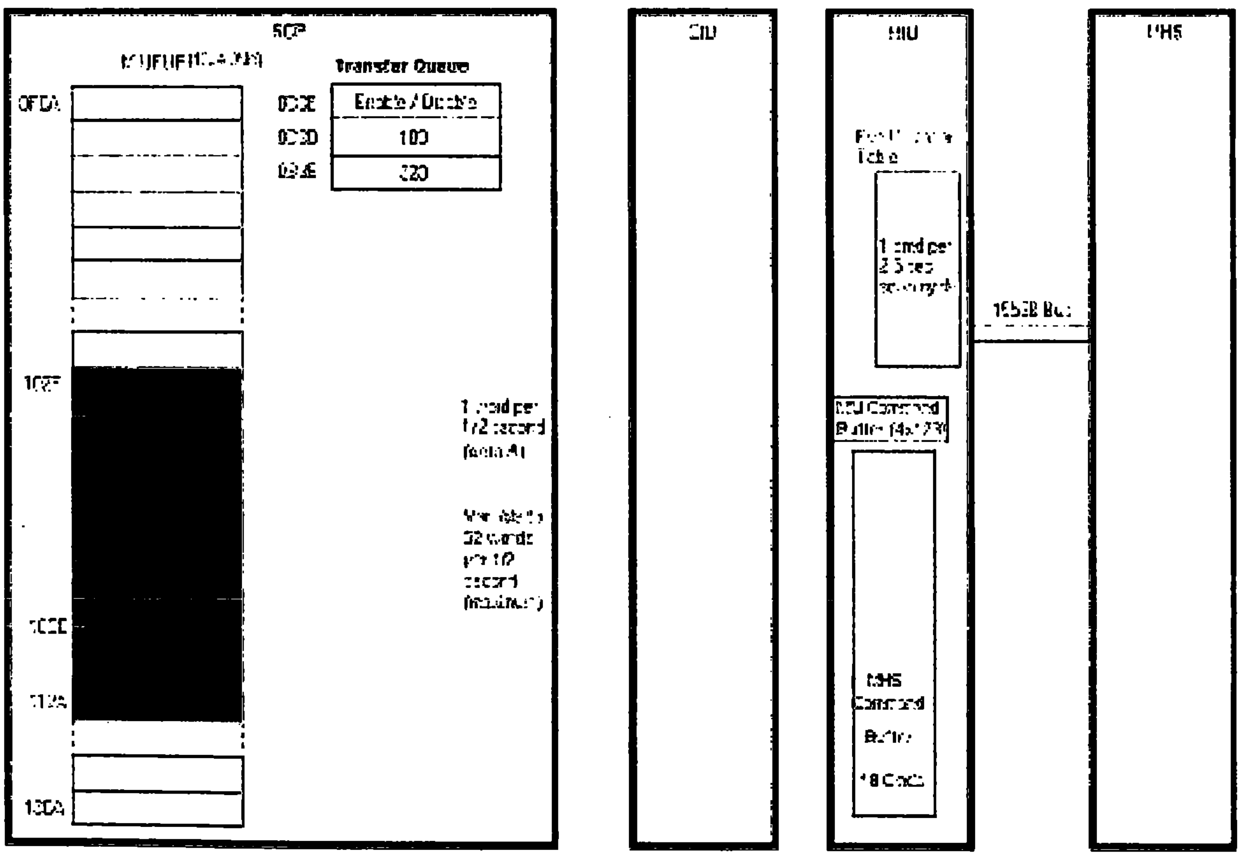



Figure 3 Serial Command Path to MIU and MHS

The NAGE then uplinks the SCP Load Block by issuing the MHSQE (MIUBUF Queue Enable) which allows the Flight Software to transfer the data (the MIU Uplink Block) serially to the CIU and ultimately to the MIU. This is all performed asynchronously, where each bit in a word is acknowledged and each sequential word is requested by the MIU when the CIU indicates that data is available. The sizing of the MIUBUF in the SCP is 1024 (16 bit) words of commands and data. The serial output transfer rate is preset, but can be modified by the MQDRT command from the two per second (default rate) to a maximum of 62 words per second. Figure 3 above illustrates the general commanding path to the MIU and MHS including the buffers that are involved.

The following is an example of the sequence of commands required to send MIU/MHS serial commands (prefaced with the Uplink codes indicated)

1) 834F MHSQI – (MHS Queue Inhibit) Prevents the CPU from transferring data to CIU until the n-words block is completely loaded.
2) 8A31 MQDRT – (MHS Queue Data Rate) Optional command, utilized only when a new transfer rate is desired from the previously set one. Establishes the rate of transfer 1-31 words per 0.5 sec (default = 1).
3) 883B MHSMC – Send Start & Stop index numbers with Checksum ( 883B word transfer wrapper)
4) Load MH_xxx or MI_xxxxx command(s) with appropriate parameters for MHS or MIU commanding.
5) 804F MHSQE– (MHS Queue Enable) Allows CPU to transfer the n-words block to CIU-MIU-MHS).

Once the data is transferred serially via the CIU to the MIU, the MIU command buffer (4 x 128 word buffer) processes the raw command to determine whether it is a MIU or MHS command. The destination ID bit within the command determines whether the data.is for the MIU to be executed immediately or whether the MIU should create a command packet, insert the data into it and then place it out on the 1553B Bus for the MHS consumption. If the MIU command buffer (4 x 128 word) gets full during this process, then the transfer requests to the SCP for further commands are not sent until this buffer has space available again. Since the processing time for an MIU instruction is in microseconds, the waiting time would be minimal, if any in a MIU transfer. However, commands being sent to the MHS can only be accepted within a 2.67 second window for each command cycle. Therefore, an 18-command word buffer has been provided in the MIU for stacking/storing pending MHS commands. As before, if this 18 command MHS buffer gets full, the MIU will be prevented from asking for more commands until it has space available in one its buffers.

As a general note throughout all of the MIU commanding operations, each command sent should have its Command Verification words verified. Any incorrect commanding or use of designated SPARE Opcodes will result in a Command Verification Error Codes returned.

### 3.2. Bootstrap Commands (TYPE 0)

The TIROS MIU Bootstrap software is GPS heritage. Interrupts are used to accept commands, process and downlink telemetry, and reset the watchdog timer (Timer B). Commands are processed in "background" mode while no interrupts are being serviced. The bootstrap function provides the start-up and initialization functions for the MIU, including:

1. Loads the bootstrap and flight code from ROM into RAM memory for later execution.
2. Initializes the hardware and software memory elements.
3. Produces telemetry output on the status of Bootstrap activities to TIP & AIP TLM streams.
4. Provides ability to initialize, load, or dump entire or parts of RAM image.
5. Provides ability to checksum the entire ROM/RAM image.
6. Provides ability to copy data from ROM to RAM and RAM to RAM.
7. Provides ability to reprogram the RAM image to alter MIU operating characteristics.

The MIU operates in one of two major states: Bootstrap and Flight mode (also referenced as Normal mode). Bootstrap mode features are located on the Bootstrap "Start Up ROM" (SUROM) code residing in the first 8K of ROM on the processor board. Bootstrap mode is automatically initiated upon the **MIU power-ON** command via the Power-On Reset (hard reset) operations. The Bootstrap loader starts at ROM location 0 and creates its BOOT image in RAM starting from location 0, performs upper RAM initialization and then control is transferred to the RAM image of Bootstrap. After initialization the boot program can access physical memory beyond the first 64K (range 0-160K) and the MIU is ready for new ground commands.

Bootstrap mode can also be initiated by issuing a discrete command "**MIU Reset**" (soft reset). The major difference between these two resets is that with the "soft" reset, the upper RAM memory contents are preserved (not cleared), thus allowing dumping of the RAM to the ground station to diagnose any anomaly that may have occurred.

Note: If five minutes expire with no MIU ground commands having been received, the Bootstrap procedure automatically performs a "GO" command (loads flight software from ROM to RAM, initializes upper memory and then automatically transfers into Flight Mode by executing code starting from RAM location 1000 Hex). The software then performs a Flight Bootstrap loader initialization and configuration, idles itself and waits for new ground commands in the Flight (Normal) mode. The initial default configuration for the MIU is the NORMAL MODE flight state with the preferred bus "A" (1553) enabled.

The following two tables indicate the bootstrap commands available and the corresponding bootstrap command formats required.

## TABLE 3.2-1: TYPE 0 – BOOTSTRAP COMMANDS

| *BASE OPCODE* | *DW NO.* | FORMAT | DESCRIPTION |
|---|---|---|---|
| 0100 | 1 | – | Clear (Clear Saved Fault Registers only) |
| 0101 | 2 | I | Transfer Control (execute instruction at address given) |
| 0102 | 1 | – | Ready (Copy FSW, Initialize Upper RAM, wait for instruction) |
| 0103 | 1 | – | Go (Copy FSW, Initialize Upper RAM, and Transfer Control) |
| 0104 | 2 | II | Read I/O |
| 0105 | 3 | III | Write I/O |
| 0106 | 5 | IV | Checksum RAM |
| 0107 | 4 | V | Checksum ROM |
| 0108 | 1 | – | Toggle TIP Data Inversion |
| 0109 | 1 | – | Toggle AIP Data Inversion |
| 010A | 1 | – | Reset TIP & AIP FIFO Registers |
| 0200 | n+4 | VI | Bootstrap Memory Load |
| 0201 | 6 | VII | Copy ROM to RAM |
| 0202 | 7 | VIII | Copy RAM to RAM |
| 0203 | 1 | – | Initialize Upper Memory |
| 0300 | 5 | IV | Dump RAM |
| 0301 | 4 | V | Dump ROM |

Note: In all the MIU Command Tables, the first Data Word (DW) is always the Command Word

## TABLE 3.2-2: TYPE 0 – BOOTSTRAP COMMAND FORMATS

| FORMAT | *DW NO.* | DESCRIPTION | RANGE |
|---|---|---|---|
| I | 2 | Address | 0..FFFF |
| II | 2 | 1750A I/O Port (must be readable) | N/A |
| III | 2<br>3 | 1750A I/O Port (must be writeable)<br>Data to be written | N/A<br>N/A |
| IV | 2-3<br>4-5 | Start Address<br>Range | 0..27FFF<br>1..28000 |
| V | 2<br>3-4 | Start Address<br>Range | 0..FFFF<br>1..10000 |
| VI | 2-3<br>4<br>5..n+4 | Target Address<br>Range<br>Data to be loaded | 0..28011<br>1..3FB<br>N/A |
| VII | 2<br>3-4<br>5-6 | Source Address<br>Range<br>Target Address | 0..FFFF<br>1..10000<br>0.27FFF |
| VIII | 2-3<br>4-5<br>6-7 | Source Address<br>Range<br>Target Address | 0.27FFF<br>1..28000<br>0.27FFF |

Opcode 0100 Hex : The ***CLEAR*** Command's purpose is to retain all prior conditions of the MIU and only clear the saved fault register information.

Opcode 0101 Hex: The ***TRANSFER CONTROL*** command is sent with the target address to transfer control into another program location. Its common usage is to exit the bootstrap mode into flight mode after some reprogrammed flight code has been loaded into the RAM image. Use of this transfer command is in lieu of using the GO command, which already includes this command but does not allow RAM reprogramming before its transfer. After this Opcode has been executed, the ROM memory will be switched off to save power and all processing continues from RAM.

Opcode 0102 Hex: The ***READY*** command causes the Flight Software to be copied from ROM to RAM and initializes upper memory. This is the first command to be issued after a soft or hard reset when it is desired to stay in the Bootstrap mode to perform other MIU bootstrap operations (such as reprogramming prior to entering Flight Mode). Issuance of this (or any other) Bootstrap command resets the timer "B" and prevents the MIU from going into the "Flight" mode automatically when no ground commands are received within 5 minutes of start-up.

Opcode 0103 Hex: The ***GO*** command causes the Flight Software to be copied from ROM to RAM, initializes memory and then begins executing the flight code, which then changes the MIU mode from the Bootstrap to the Flight Mode. This command is only issued when additional bootstrap commands are not required and ready to exit into the active or flight mode. After this Opcode has been executed, the ROM memory will be switched off to save power and all processing continues from RAM.

Opcode 0104 Hex: The ***READ I/O*** command allows reading the MIU 1750 ports and is usually reserved for diagnostic purposes. The ***READ I/O Reply Type (0)*** contains the data requested in the Command Verification Telemetry.

Opcode 0105 Hex: The ***WRITE I/O*** command allows writing to a MIU 1750 port and is usually reserved for diagnostic purposes. The ***WRITE I/O Reply Type (1)*** echoes back the written data in the Command Verification Telemetry.

Opcode 0106 Hex: The ***CHECKSUM RAM*** command allows writing checksum values to the RAM in the MIU, usually performed for reprogramming purposes. The *CHECKSUM RAM* ***Reply Type (2)*** echoes back the written data in the Command Verification Telemetry.

Opcode 0107 Hex: The ***CHECKSUM ROM*** command allows verifying checksum values of the ROM in the MIU. The *CHECKSUM RAM* ***Reply Type (3)*** contains the checksum data in the Command Verification Telemetry.

Opcode 0108 Hex: The ***TOGGLE TIP DATA INVERSION*** command complements the data going out to the TIP interface and is normally reserved for diagnostic purposes.

Opcode 0109 Hex: The ***TOGGLE AIP DATA INVERSION*** command complements the data going out to the AIP interface and is normally reserved for diagnostic purposes.

Opcode 010A Hex: The *Reset* ***TIP & AIP FIFO*** *Registers* command allows a method of clearing the FIFOs and is normally reserved for diagnostic purposes.

Opcode 0200 Hex: The ***BOOTSTRAP MEMORY LOAD*** command writes into the memory range previously specified. This command is useful in reprogramming applications.

Opcode 0201 Hex: The ***COPY ROM TO RAM*** Command is used to recopy ROM contents into RAM again or to a new RAM address. Target Address and Range are specified followed by the upload data. The upload is confirmed by Checksum RAM, Opcode 0106 Hex, and/or by Memory Dump, Opcode 0300 Hex. ROM Checksum is Opcode 0107 Hex and Dump ROM 0301 Hex.

Opcode 0202 Hex: The ***COPY RAM TO RAM*** Command is used to copy specified RAM contents into other RAM location(s). The verification process is confirmed by Checksum RAM, Opcode 0106 Hex, and/or by Memory Dump, Opcode 0300 Hex.

Opcode 0203 Hex: The ***INITIALIZE UPPER MEMORY*** Command clears upper memory upon this command. This command is already included and part of the READY and GO commands.

Opcode 0300 Hex: The ***DUMP RAM*** Command is used to download specified RAM contents into Bootstrap TLM for verification purposes.

Opcode 0301 Hex: The ***DUMP ROM*** Command is used to download specified ROM contents into Bootstrap TLM for verification purposes.

### 3.3. Single Integer Load Commands (TYPE 1)

Type 1 commands are used to set signed integer parameters within the flight software. Opcodes used to store specific single integers are limited and described in the table below. Default values are used if these have not been set by ground command. The Type 1 command format, as shown below, is the standard two-word command.

**TABLE 3.3-1: TYPE 1 – SINGLE INTEGER LOAD COMMANDS**

| ***OPCODE*** | ***DESCRIPTION*** | ***RANGE*** | ***SUBSYSTEM*** |
|---|---|---|---|
| 1000 | SPARE | | |
| 1001 | Minor Frame Reccption Tolerance | 0..2000 | TIME MANAGER |
| 1002 | Exception Log Save Index | 0..49 | ERROR |
| 1003 | Interrupt Log Save Index | 0..49 | |
| 1004 - 101F | SPARES | | |

*TYPE 1 COMMAND FORMAT*

| | |
|---|---|
| OPCODE | DW 1 |
| 16 BIT (SIGNED) INTEGER | DW 2 |

Opcode 1000 Hex: SPARE and not used.

Opcode 1001 Hex : The ***Minor Frame Reception Tolerance*** command allows a setting within the range 0 to 2000 ticks (decimal). The tolerance is used to determine if the minor cycle arrived at the approximate expected time. The value is in Timer A ticks, with 1 tick = 10 microseconds. The range covers tolerances from +/- 0% to +/- 20%. The default is 2% or 200 ticks. The mid-point of a minor cycle in Timer "A" ticks defaults to 10,000 ticks. If the minor cycle is received outside the range 9,800

> T > 10,200 then the Minor Cycle Error count is incremented and is inserted into the downlink telemetry.

Opcodes 1002 Hex: The ***Exception Log Save Index*** command preloads an index value into the Slow Dump Submode Exception Log Table. This value is limited to a range of 0 to 49 decimal, the maximum number of table slot entries available. The Log Save Indexes are initially set to save the first 15 entries (default index=15). Each exception is recorded sequentially starting from the first position of this log table until the $51^{st}$ entry occurs. Then beginning at 'Index'+1 (16 in this case), each record will be overwritten as each additional (51st and above) entry is registered but the original 15 are left preserved (saved).

Note that this command, Opcode 1002, is a preparatory command and has no initial effect when sent alone. It must be followed by issuing an ACTION COMMAND, Opcode 9003 Hex, which will actually clear the log of all data and actually set the new *Exception Log Save Index* desired.

Opcodes 1003 Hex: The ***Interrupt Log Save Index*** command preloads an index value into the Slow Dump Submode Interrupt Log Table. This command operates identically to the Exception Log Save Index above. Note that this command, Opcode 1003, is also a preparatory command and has no initial effect when sent alone. It must be followed by issuing an ACTION COMMAND, Opcode 9004 Hex, which will actually clear the log of all data and actually set the new *Interrupt Log Save Index* desired.

Opcodes 1004 to 101F Hex are SPARE and not used.

### 3.4. Extended Integer Load Commands (TYPE 2)

Opcodes 2000 to 201F Hex are all SPARE and not used.

### 3.5. Single Unsigned Integer Load Commands (TYPE 3)

Type 3 Commands set parameters related to Memory Dump word counts and varied BCRTM Bus operation retry limits. The command format, shown separately below, is the standard two word command.

**TABLE 3.5-1: TYPE 3 – SINGLE UNSIGNED INTEGER LOAD COMMANDS**

| *OPCODE* | *DESCRIPTION* | *RANGE* | *SUBSYSTEM* |
|---|---|---|---|
| 3000 | SPARE | | |
| 3001 | Housekeeping Bus Memory Dump Word Count | 0..65535 | HK |
| 3002 | Science Bus Memory Dump Word Count | 0..65535 | SCI |
| 3003 | Housekeeping Bus Request Retry Limit | 0..65535 | HK |
| 3004 | Housekeeping Bus TVW Retry Limit | 0..65535 | |
| 3005 | Housekeeping Bus Reset Retry Limit | 0..65535 | |
| 3006 | Science Bus Request Retry Limit | 0..65535 | SCI |
| 3007 | Science Bus TVW Retry Limit | 0..65535 | |
| 3008 | Science Bus Reset Retry Limit | 0..65535 | |
| 3009 | BIT/Wrap Test Retry Limit | 0..65535 | MISC |
| 300A | Bus Command Retry Limit | 0..65535 | CMD |
| 300B | BIT Iterations | 1..6 | BCRTM |
| 300C | RESET Iterations | 1..3 | |
| 300D - 301F | SPARES | | |

*TYPE 3 COMMAND FORMAT*

| | |
|---|---|
| OPCODE | DW 1 |
| 16 Bit (Unsigned) INTEGER | DW 2 |

Opcode 3000 Hex: is SPARE and not used.

Opcode 3001 Hex: The ***Housekeeping (HK) Bus Memory Dump Word Count*** command is a preparatory command and must be issued before issuing a HK memory dump operation using Action Command (TYPE 9) Opcode 9009 Hex.

Opcode 3002 Hex: The ***Science (SCI) Bus Memory Dump Word Count*** command is a preparatory command and must be issued before issuing a SCI memory dump operation using Action Command (TYPE 9) Opcode 9009 Hex.

Opcode 3003 Hex: The ***Housekeeping (HK) Bus Request Retry Limit*** command sets a new limit for retries from the default value of two. If a Bus Transaction is incomplete due to overrun or if a Bus Validation fails, the HK operation is retried "limit + 1" times. When the limit is exceeded, the Failed Periods counter is incremented.

Opcode 3004 Hex: The ***Housekeeping Bus TVW Retry Limit*** command sets a new retry limit from the default value of two. If a Bus Transaction, Bus Validation, or a Transmit Vector Word (TVW) Service Request (SRQ) Check fails, the operation is retried "limit + 1" times. When the limit is exceeded, the Failed Periods counter is incremented.

Opcode 3005 Hex: The ***Housekeeping Bus Reset Retry Limit*** command sets a new retry limit from the default value of two. If a Bus Transaction, Validation, or Telemetry Packet Validation fails, the operation is retried "limit + 1" times. When the limit is exceeded, the Failed Periods counter is incremented.

Opcode 3006 Hex: The ***Science Bus Request Retry Limit*** command has the same defaults and behavior as the HK titled version above.

Opcode 3007 Hex: The ***Science Bus TVW Retry Limit*** command has the same defaults and behavior as the HK titled version above.

Opcode 3008 Hex: The ***Science Bus Reset Retry Limit*** command has the same defaults and behavior as the HK titled version above.

Opcode 3009 Hex: The ***BIT/Wrap Test Retry Limit command***, sets a new retry limit from the default value of two. If a Bus Transaction is incomplete for its Built-In-Test (BIT) or Wrap-around self-test, the operation is retried "limit + 1" times. When the limit is exceeded, the Failed Periods counter is incremented.

Opcode 300A Hex: The ***Bus Command Retry Limit*** command, sets a new retry limit from the default value of five (5). If a Bus Command or Transaction is incomplete, the operation is retried "limit + 1" times. When the limit is exceeded, the Skipped Command counter is incremented.

Opcode 300B Hex: The ***Built-in-Test (BIT) Iterations*** command, sets a new retry limit from the default value of three (3). BIT is conducted when the 1553B BCRTM chip is initialized. The BCRTM chip is polled until the BIT is complete or the limit is exceeded. Each time it is polled the BIT Time Out counter is incremented.

Opcode 300C Hex: The ***Reset Iterations*** command sets a new retry limit from the default value of two (2). A reset is conducted when the 1553B BCRTM Chip is initialized. The BCRTM chip is polled until the reset is complete or the limit is exceeded. Each time it is polled, the Reset Time Out counter is incremented.

Opcodes 300D to 301F Hex: are SPARE and not used.

### 3.6. Extended Unsigned Integer Load Commands (TYPE 4)

Type 4 Commands set the Major Cycle Number and various prerequisite parameters related to Memory Dumps. As shown below, the command Type 4 format is a three (3) word command.

**TABLE 3.6-1: TYPE 4 – EXTENDED UNSIGNED INTEGER LOAD COMMANDS**

| *OPCODE* | *DESCRIPTION* | *RANGE* | *SUBSYSTEM* |
|---|---|---|---|
| 4000 | SPARE | | |
| 4001 | Major Cycle Number | 0..(2^31)-1 | TIME MNGR |
| 4002 | Memory Dump Start Address | 0..27FFF | TELEMETRY |
| 4003 | Memory Dump Range | 1..28000 | |
| 4004 | Housekeeping Bus Dump Start Address | 0..1FFFF | HK |
| 4005 | Science Bus Dump Start Address | 0..1FFFF | SCI |
| 4006 - 401F | SPARES | | |

*TYPE 4 COMMAND FORMAT*

| | |
|---|---|
| OPCODE | DW 1 |
| 15 MS Bit Integer (S=0) | DW 2 |
| 16 LS Bit Integer | DW 3 |

Opcode 4000 Hex: is SPARE and not used.

Opcode 4001 Hex: The ***Major Cycle Number*** command presets the MIU major cycle to a new value within a range of 0 to $(2^{31})-1$. This a preparatory command prior to issuing a Discrete Command (TYPE 7/8) Opcode 7001 Hex where the new value actually becomes active.

Opcode 4002 Hex: The ***Memory Dump Start Address*** is a preparatory command, setting the required address parameter prior to issuing a memory dump operation using the Action Command (TYPE 9) Opcode 9002 or 9006 Hex.

Opcode 4003 Hex: The ***Memory Dump Range*** is a preparatory command, setting the required range parameter prior to issuing a memory dump command, an Action Command (TYPE 9) operation.

Opcode 4004 Hex: The ***Housekeeping Dump Start Address*** is a preparatory command, setting the required address parameter prior to issuing a memory dump operation using the Action Command (TYPE 9) Opcode 9002 or 9009 Hex.

Opcode 4005 Hex: The ***Science Dump Start Address*** is a preparatory command, setting the required address parameter prior to issuing a memory dump operation using the Action Command (TYPE 9) Opcode 9002 or 9009 Hex.

Opcode 4006 to 401F Hex: are SPARE and not used.

### 3.7. Single Floating Point Load Commands (TYPE 5)

Opcodes 5000 to 501F Hex: are all SPARE and not used..

### 3.8. Discrete Commands (TYPE 7/8)

The Type 7/8 Discrete Commands toggle modes or enable/disable operations. Generally, the 70XX Hex Opcode will turn on or enable an operation, whereas the 80XX Hex Opcode will turn off or disable the operation. All these commands are one word (Opcode only) commands. In the TYPE 7/8 table below, all the "NU" entries indicate "NOT USED"

**TABLE 3.8-1: TYPE 7/8 - DISCRETE COMMANDS**

| *OPCODE* | | *DESCRIPTION* | *DEFAULT* |
|---|---|---|---|
| *ON* | *OFF* | | |
| 7000 | 8000 | SPARE | |
| 7001 | NU | Set New Major Cycle | Not set |
| NU | 8002 | Re-Sync to Major Cycle | ON |
| 7003 | NU | Reset TIP FIFO Register | OFF |
| 7004 | NU | Reset AIP FIFO Register | OFF |
| 7005 | 8005 | Invert TIP FIFO Data Output | OFF |
| 7006 | 8006 | Invert AIP FIFO Data Output | OFF |
| 7007 | 8007 | Enable Memory Scrub | ON |
| 7008 | 8008 | Enable Memory Checksum | ON |
| 7009 | 8009 | Enable Bus Controller | OFF2ON* |
| 700A | 800A | Enable Miscellaneous Bus Transactions | ON |
| 700B | 800B | Enable Housekeeping Bus Transactions | ON |
| 700C | 800C | Enable Science Bus Transactions | ON |
| 700D | 800D | Enable Command Bus Transactions | ON |
| 700E | 800E | Enable NIL Bus Transactions | ON |
| 700F | 800F | Enable TIP Engineering Frame | OFF |
| 7010 | 8010 | Enable WRAP Test Pattern Modification | ON |
| 7011 | 8011 | Select Ground Preferred Bus (ON=A, OFF=B) | ON = A bus |
| 7012 – 701F | 8012- 801F | SPARES | |

* This default condition indicates "enabling" but inactive (Not ON).

Opcodes 7000 and 8000 Hex: are SPARE and not used.

Opcode 7001 Hex: The ***Set New Major Cycle*** command will force the cycle count set by the TYPE 4 command *Major Cycle Number* (Opcode 4001 Hex) to become active.

Opcode 8002 Hex: The ***Re-Sync to Major Cycle (OFF)*** command causes a FALSE status of the MIU major frame sync with the TIP. In software terms, it sets "Major_Cycle_Sync" to FALSE. This will cause the software to re-sync its timing at the start of the next major TIP frame. The software will autonomously set this flag to FALSE to force a re-sync whenever major frame sync is lost. Ground may not issue a Re-Sync. Command directly to the MIU, but can set this re-sync flag.

Opcode 7003 Hex: The ***Reset TIP FIFO Register (ON)*** command issues a pulsed reset signal, which clears the FIFO. The FIFO will then automatically go back to its normal operations (buffering TIP TLM stream entries) without additional commands.

Opcode 7004 Hex: The ***Reset AIP FIFO Register (ON)*** command issues a pulsed reset signal, which clears the FIFO. The FIFO will then automatically go back to its normal operations (buffering AIP TLM stream entries) without additional commands

Opcode 7005 and 8005 Hex Invert ***TIP FIFO Data Output*** command (On) vs. (OFF) is devoted to diagnostic routine requirements, since the data would not normally need to be inverted.

Opcode 7006 and 8006 Hex Invert ***AIP FIFO Data Output*** command (On) vs. (OFF) is devoted to diagnostic routine requirements, since the data would not normally need to be inverted.

Opcode 7007 and 8007 Hex Enable ***Memory Scrub*** command (On) vs. (OFF) allows diagnostic ground control over this function.

Opcode 7008 and 8008 Hex Enable ***Memory Checksum*** command (On) vs. (OFF) allows anomaly and diagnostic ground control over this function.

Opcode 7009 and 8009 Hex Enable ***Bus Controller*** command (On) vs. (OFF) allows control of the MIU Bus Controller (BC) functions over 1553 bus to the MHS. The default is "inactive", so the (ON) command must be issued to begin 1553 transactions to the MHS.

Opcode 700A and 800A Hex Enable ***Miscellaneous Bus Transactions*** command (On) vs. (OFF) allows anomaly and diagnostic ground control over this function. The default condition is "ON".

Opcode 700B and 800B Hex Enable ***Housekeeping Bus Transactions*** command (On) vs. (OFF) allows anomaly and diagnostic ground control over this function. The default condition is "ON".

Opcode 700C and 800C Hex Enable ***Science Bus Transactions*** command (On) vs. (OFF) allows anomaly and diagnostic ground control over this function. The default condition is "ON".

Opcode 700D and 800D Hex Enable ***Command Bus Transactions*** command (On) vs. (OFF) allows anomaly and diagnostic ground control over this function. The default condition is "ON".

Opcode 700E and 800E Hex Enable ***NIL Bus Transactions*** command (On) vs. (OFF) allows anomaly and diagnostic ground control over this function. The default condition is "ON".

Opcode 700F and 800F Hex Enable ***TIP Engineering Frame*** command (On) vs. (OFF) allows anomaly and diagnostic ground control over this function. The default condition is "OFF".

Opcode 7010 and 8010 Hex Enable ***WRAP Test Pattern Modification*** command (On) vs. (OFF) allows anomaly and diagnostic ground control over this function. The default condition is "ON".

Opcode 7011 and 8011 Hex: The ***Select Ground Preferred Bus*** command (ON) vs. (OFF) selects either MIU 1553 Bus "A" or Bus "B" respectively, for the MIU to MHS transactions. Under normal conditions, TLM indications for "MIU Preferred Bus", and "Last Bus Used" all would match the ground selected Bus selection "Ground Preferred Bus" and continue to all stay the same until commanded again. However, the "MIU Preferred Bus" selection is automatically switched to the alternate bus if the MIU experiences 1553B errors in transmission. In that case, the normal TLM indications of the "Ground Preferred Bus", "MIU Preferred Bus", and "Last Bus Used" all agreeing would not prevail. The default selection (Ground Preferred Bus "A") is used if any ground command has not been issued.

Opcodes 7012 to 701F Hex: are SPARE and are not used.

Opcodes 8012 to 801F Hex: are SPARE and are not used.

## 3.9. Action Commands (TYPE 9)

Type 9 Action Commands are used to cause actions, such as state or mode changes within the MIU or begin memory or table dumps or provides changes to the operation of the 1553B Data Bus.

**TABLE 3.9-1: TYPE 9 – ACTION COMMANDS**

| OPCODE | *DW NO.* | DESCRIPTION |
|---|---|---|
| 9000 | – | SPARE |
| 9001 | 1 | Clear Errors and Counters |
| 9002 | 2 | Set MIU Telemetry Mode<br>DW2: Mode (0-Normal 1-Fast Dump 2-Slow Dump 3-Very Slow Dump 4-Bus Engineering Mode) |
| 9003 | 1 | Clear Exception Log and Set New Save Index |
| 9004 | 1 | Clear Interrupt Log and Set New Save Index |
| 9005 | 4 | Set Interrupt Table Entry<br>DW2: Interrupt (0..15)<br>DW3: Type (0-Application 1-ISR Enabled 2- ISR Polled)<br>DW4: Behavior (0-Log 1-Log and Go Idle) |
| 9006 | 2 | Read 1750A I/O Port<br>DW2: 1750A I/O Port (must be readable) |
| 9007 | 3 | Write 1750A I/O Port<br>DW2: 1750A I/O Port (must be writeable)<br>DW3: Data to be written |

## *TYPE 9 – ACTION COMMANDS (CONT.)*

| OPCODE | *DW NO.* | DESCRIPTION |
|---|---|---|
| 9008 | 2 | Select Slow Dump Submode<br>DW2:Submode 0-Exception Log, 1-Interrupt Log, 2-AIP CV Queue, 3-TIP CV Queue, 4-Memory Scrub Table, 5-Memory Checksum Table, 6-Bus Utilization Table, 7-SCI Machine Error Table, 8-HK Machine Error Table, 9-CMD Machine Error Table, 10-MISC Machine Error Table |
| 9009 | 2 | Set Bus Controller Mode<br>DW2: Mode (0-TLM 1-HK Dump 2-SCI Dump) |
| 900A | – | SPARE |
| 900B | 1 | Clear MHS Command Queue |
| 900C | 1 | Reset Bus Controller |
| 900D | 1 | Reset Housekeeping Bus Processing |
| 900E | 1 | Reset Science Bus Processing |
| 900F | 1 | Reset Bus Command Processing |
| 9010 | 1 | Reset BIT/Wrap Test Processing |
| 9011 | 6 | Modify Bus Utilization Table<br>DW2: Scan Period (0..2 Scan Period Range)<br>DW3: Transaction Slot (0..9)<br>DW4: Enabled (0-False, 1-True)<br>DW5: Transaction (0-NIL, 1-MISC, 2-HK, 3-SCI, 4-CMD)<br>DW6: End Cycle (0..79 Minor Cycle Range) |
| 9012 thru 901D | – | SPARE |
| 901E | 2 | Read BCRTM Register<br>DW2: BCRTM Register (1..10,14,16,17,18) |
| 901F | 3 | Write BCRTM Register<br>DW2: BCRTM Register (0,2..4,6..14,16,17)<br>DW3: Data to be written |

Note: Data Word (DW) 1 is always the Command Word (Opcode).

Opcode 9000 Hex: is SPARE and not used.

### 3.9.1. Clear Errors and Counters

Opcode 9001 Hex - ***Clear Errors and Counters*** command will initialize the following items as listed in the table below:

**TABLE 3.9.1-1 Opcode 9001 Clear Error and Counters**

| Flag or Counter | Reset State |
|---|---|
| Uplink Queue Is Full | FALSE |
| Uplink Queue Was Reset | FALSE |
| Unexpected ISR Counters | 0 |
| TIP was Reset | FALSE |
| TIP Full | FALSE |
| TIP Empty | FALSE |
| AIP was Reset | FALSE |
| AIP Full | FALSE |
| AIP Empty | FALSE |
| Main Cycle Counter | 0 |
| Bit Error Counter | 0 |
| Checksum Error Counter | 0 |
| Stuck Bit Detected | FALSE |
| Stuck Bit Address | 0 |
| Minor Cycle Error Counter | 0 |
| BC Unexplained Exceptions | 0 |
| Bus Overrun Occurred | FALSE |
| Last Cmd During Overrun | 0 |

### 3.9.2. Set MIU Telemetry Modes

Opcode 9002 ***Set MIU Telemetry Mode*** command, along with its corresponding data word (DW2), sets one of the five major operational modes within the MIU: Normal, Fast Dump, Slow Dump, Very Slow Dump, or Bus Engineering Mode. Normal mode is the standard flight mode configuration while the other four are to facilitate anomalous conditions. Choice of the available three dump modes depends on the urgency and conditions requiring the dump. If the MIU is displaying severe anomalous behavior then fast mode is most appropriate because this mode provides quick dump data and the still provides minimal MHS/ MIU housekeeping telemetry. If routine diagnostics are being run, then the slow mode is appropriate because the MHS science data telemetry stream continues undisturbed. If a problem occurs with the AIP telemetry downlink, then the very slow dump would be appropriate as it is entirely within the TIP data stream. The Bus Engineering mode facilitates troubleshooting MIU/MHS 1553 bus related functions.

#### 3.9.2.1. Set MIU TLM Mode -Normal Mode

Opcode 9002 and DW2= 0000 Hex, commands the MIU to ***Normal Telemetry mode***. This allows full AIP and TIP telemetry with all Housekeeping and Science data to flow from the MIU and MHS. This is the initial default mode for the MIU telemetry, but this command is also utilized to exit other MIU modes.

#### 3.9.2.2. Set MIU TLM Mode -Fast Memory Dump

Opcode 9002 and DW2= 0001 Hex selects the ***Fast Telemetry Dump*** causing the MIU to replace some AIP data with memory dump data while the TIP telemetry is not affected. This results in 25 16-bit words in AIP frame bytes 48-97 downloaded per minor frame (MIU slots 5,6 and 98...101 are unaffected) as detailed in the TLM schedule for the fast dump. The memory dump location must be previously specified with TYPE 4 Commands, Opcode 4002 and 4003 Hex, to set the start address and dump range.

Transition to this mode occurs at the major frame and the address of the dump is placed in each minor frame in slots 48 to 51. Dump data follows in slots 52 to 97 for each minor frame. The dump complete flag is set when the dump range is reached. As needed, fill words will be added to the download to pad from the end of dump range until the major frame starts the pending mode. The memory dump start and range (TYPE 4 Commands, Opcode 4002 and 4003 Hex) are not reset during this process or by a transition to another telemetry mode.

#### 3.9.2.3. Set MIU TLM Mode -Slow Dump Mode

Opcode 9002 and DW2= 0002 Hex, command invokes the ***Slow Dump Mode***, which replaces the data in the MIU AIP housekeeping telemetry stream with MIU dump data. While in this mode, the TIP telemetry is not affected and AIP science data in slots 48 to 97 is unaffected. This results in one (1) 16-bit word placed in AIP frame bytes 6 & 7 plus two (2) 16-bit words of dump data placed in slots 98-101 per minor frame. The current dump address will be sent every major frame in slots 98-101.

Prior to placing the MIU into the Slow Dump Mode, the Slow Dump Sub-Mode Selection (Opcode 9008) must be previously specified, selecting one of the 10 available sub-modes as shown in the above table.

#### 3.9.2.4. Set MIU TLM Mode -Very Slow Dump Mode

Opcode 9002 and DW2= 0003 Hex, command invokes the ***Very Slow memory dump*** mode replacing the MIU TIP housekeeping telemetry stream with MIU dump data. None of the AIP telemetry is affected. Therefore, one 8-bit word (TIP frame byte 102) is down linked per TIP minor frame. The memory dump location must be previously specified with TYPE 4 Commands.

#### 3.9.2.5. Set MIU TLM Mode -Bus Engineering Mode

Opcode 9002 and DW2= 0004 Hex command places the MIU into the ***BUS Engineering Mode***. The Bus Engineering Mode is provided for diagnostic purposes and dumps data related to the MIL-STD-1553B Bus interfaces between the MIU and MHS. It does this in five formats of twenty-five (25) words each similar to a fast dump mode. These BUS modes include NIL, MISC., HK, SCI, and CMD. These five formats may be enabled / disabled with the TYPE 7/8 Discrete Commands.

The Miscellaneous format is used to dump the BIT and WRAP test data. The HK and SCI formats collect data related to the HK and SCI data streams and the CMD format sequences through the Command and I/O data. A transaction table is used to determine which of these five sub-tables are used for a particular minor frame. It is based on the three MHS Scan Periods per Major Frame. Each format uses a table pointer, pointing to the data to add to the telemetry stream.

### 3.9.3. Clear Exception Log and Set new Save Index

Opcode 9003 Hex: The ***Clear Exception Log and Set new Save Index*** command will clear the Exception Log and set the Save Index active to the value previously set by the *TYPE 1 Opcode 1002* command. The Save index sets the place (1 to 50) where the Exception Log will wrap and begin overwriting data once the entries exceed 50.

### 3.9.4. Clear Interrupt Log and Set new Save Index

Opcode 9004 Hex: The ***Clear Interrupt Log and Set new Save Index*** command will clear the Interrupt Log and set the Save Index active to the value previously set by the *TYPE 1 Opcode 1003* command. The Save index sets the place (1 to 50) where the Exception Log will wrap and begin overwriting data once the entries exceed 50.

### 3.9.5. Set Interrupt Table Entry

Opcode 9005 Hex: The ***Set Interrupt Table Entry*** command allows the ground to replace an interrupt vector and assists with reprogramming the MIU if needed. As shown in the table below, this command is a four data word (DW) command, requiring interrupt number, type and behavior parameters submitted in order to modify the Interrupt Table entries.

**TABLE 3.9.5-1 - Interrupt Table Entry Command Format**

| | | |
|---|---|---|
| DW1 | Opcode | 9005H |
| DW2 | Interrupt | 0..15 |
| DW3 | Type | 0=Application, 1= ISR Enabled, 2= ISR polled |
| DW4 | Behavior | 0=Log, 1=Log and Go Idle |

### 3.9.6. Read 1750A I/O Port

Opcode 9006 Hex: This two word command reads data from a MIU CPU 1750A I/O Port. The DW2 parameter requires that an I/O Port number be provided. The 16 bit data output results appears in AIP TLM Bytes 98-99 of minor frames 3, 23, 43, and 63 designated as "Results of I/O Read".

### 3.9.7. Write 1750A I/O Port

Opcode 9007 Hex: This three word command writes data to a MIU CPU 1750A I/O Port. The DW2 parameter specifies the I/O Port number to be written to and the DW3 contains the data to be written.

### 3.9.8. Select Slow Dump Submode

Opcode 9008 Hex: The ***Select Slow Dump Submode*** command is a two word command where DW2 selects one of the 10 Submodes available in the Slow Dump mode. The Slow Dump Submode command is issued prior to commanding the MIU into the Slow Dump mode (Opcode 9002 with WD2= 2) ref Para [3.9.2.3]. After both commands are correctly issued, the results are one (1) 16-bit word placed in AIP frame bytes 6 & 7 plus two (2) 16-bit words of dump data placed in slots 98-101 per each minor frame. The current dump address will be sent every major frame in slots 98-101. When the dump is complete, the dump will not automatically transition back to Normal mode but will continue to dump the selected table until re-commanded by the ground. Fill data will pad the dump words 98-101after the maximum number of items (data entries) has been downloaded. This continues until the next major frame, where the dump process will restart again. The Table below indicates the start addresses of the logs, queues, tables and length in 16-bit words for the Slow Dump Submode.

**TABLE 3.9.8-1 - SLOW DUMP SUBMODE TABLE**

| Sub mode | Name | Start Physical Address | Number of Items | Size (Words) | Total Words |
|---|---|---|---|---|---|
| 0 | EXCEPTION_LOG | 1157D | 50 | 6 | 300 |
| 1 | INTERRUPT_LOG | 1141B | 50 | 7 | 350 |
| 2 | AIP CV QUE | 11AEA | 50 | 1 | 50 |
| 3 | TIP CV QUE | 11AB8 | 50 | 1 | 50 |
| 4 | SCRUB_TABLE | 119E9 | 20 | 5 | 100 |
| 5 | CHECKSUM_TABLE | 1195F | 20 | 6 | 120 |
| 6 | BUS TRANSACTION_SCHEDULE | 11A51 | 30 | 3 | 90 |
| 7 | SCI_ERROR_TABLE | 1117F | 100 | 6 | 600 |
| 8 | HK_ERROR_TABLE | 10F02 | 100 | 6 | 600 |
| 9 | CMD_ERROR_TABLE | 109EC | 100 | 6 | 600 |
| 10 | MISC_ERROR_TABLE | 10C5D | 100 | 6 | 600 |

As an example of a log file output format, the following **Interrupt Log Dump** is shown:

**TABLE 3.9.8-2- INTERRUPT LOG DUMP EXAMPLE**

| Major Frame | Address | Comment |
|---|---|---|
| N | 01141B | Start Dump |
| N+1 | 0114B9 | 158 words |
| N+2 | 011557 | 316 words |
| -- | 011579 | 350 words end (not sent in dump) |
| N+3 | 01141B | pad 124 words w/ filler & restart |

### 3.9.9. Set Bus Controller Mode

Opcode 9009 Hex: The ***Set Bus Controller Mode*** command is a two word command. DW2 of this command sets the bus controller to Telemetry (normal operations), Housekeeping (HK) Dump, or Science (SCI) Dump modes. Normal telemetry mode is the regular operational configuration providing standard AIP and TIP data streams. Both the HK and SCI Dump modes read memory directly from the MHS Bus memory over the 1553B Bus interface as previously set by the TYPE 3 (Opcodes 3001/2 Hex) and TYPE 4 (4004/5 Hex) Commands. The dump data is output into AIP or TIP telemetry as previously set by those commands.

### 3.9.10. SPARE Opcode 900A Hex

Opcode 900A Hex: is SPARE and not used.

### 3.9.11. Clear MHS Command Queue.

Opcode 900B Hex: The ***Clear MHS Command Queue*** is a one word command, which clears the 18-command word MHS FIFO queue within in the MIU. Each MHS command can have up to seven (7) data words attached.

### 3.9.12. Miscellaneous Reset Commands

Opcodes 900C thru 9010 Hex: The Bus Reset commands listed in the table below will reset specified 1553 Bus Processing software to initial states. This is the heart of the MIU to MHS communication operations and would only be used to clear some anomalous condition. They are all single word commands requiring no additional parameters.

**TABLE 3.9.12-1 - Bus Reset Commands**

| Opcode | Description | Actions Performed |
|---|---|---|
| 900C | Reset Bus Controller | * See below |
| 900D | Reset HK Bus Processing | 1. Reset Bus operations on respective subsystem.<br>2. Machine State set to Idle<br>3. Current Mode cancelled<br>4. Clear all associated counters, data, tables or indices |
| 900E | Reset Science Bus Processing | |
| 900F | Reset Bus Cmd Processing | |
| 9010 | Reset BIT/Wrap Test Processing | |

*Opcode 900C: The ***Reset Bus Controller*** command performs the following actions:

1. The Bus Controller is set to TLM Mode.
2. Current Transaction pointer is to the first item of the data table.
3. Bus Controller State is set to OFF2ON (Suspended Operations Mode).
4. Transaction Schedule is set to the first item.
5. Transactions in progress are cancelled.
6. Transaction types are set to enabled (MISC, HK, SCI, CMD).
7. State Machines are reset (MISC, HK, SCI, CMD).
8. Interrupt Log is reset.

Note: Since the Bus Controller controls all the other processes, when Opcode 900C hex is issued (resetting the Controller), all Opcodes 900D to 9010 are also effectively executed. Therefore sending Opcode 900C and any other Opcode in this set is not required.

### 3.9.13. Modify Bus Utilization Table

Opcode 9011 Hex: The ***Modify Bus Utilization Table*** command will overwrite a single Bus Utilization Table entry. This command is sent with five (5) additional parameter data words (DW) as shown in the table below. The purpose of this command is the change the command sequence/timing of the Bus Controller and would not be used unless reprogramming or special diagnostics are necessary.

**TABLE 3.9.13-1- Bus Utilization Table Upload Command Example**

| DW# | Description | Parameter/Value |
|---|---|---|
| DW1 | OPCODE | 9011 Hex |
| DW2 | Scan Period Range | 0..2 |
| DW3 | Transaction Slot | 0..9 |
| DW4 | Enabled | 0-False, 1-True |
| DW5 | Transaction | 0-NIL, 1-MISC, 2-HK, 3-SCI, 4-CMD |
| DW6 | End Cycle | 0..79 Minor Cycle Range |

### 3.9.14. SPARE Opcodes

Opcodes 9012 to 901D Hex: are SPARE and not used.

### 3.9.15. Read BCRTM Register / Write BCRTM Register

Opcode 901E Hex: The ***Read BCRTM Register*** command is a two word command that will read one register from the BC chipset. The following table defines the registers by number, as required for the DW2 parameter for this command. Consideration must be given to the register selected, insuring it can be read.

**TABLE 3.9.15-1 - MIL-STD-1553B BCRTM Registers and I/O Locations**

| Reg No. | BCRTM Register | PHYSICAL ADDRESS | LOGICAL ADDRESS | Read/ Write |
|---|---|---|---|---|
| 0 | Control | 28000 | C000 | RW |
| 1 | Status | 28001 | C001 | R |
| 2 | Current Command Block, | 28002 | C002 | RW |
| 3 | Polling Compare | 28003 | C003 | RW |
| 4 | BIT Word | 28004 | C004 | RW |
| 5 | Current Command | 28005 | C005 | R |
| 6 | Interrupt Log List Pointer | 28006 | C006 | RW |
| 7 | High Priority Interrupt Enable | 28007 | C007 | RW |
| 8 | High Priority Interrupt Status Reset | 28008 | C008 | RW |
| 9 | Standard Interrupt Enable | 28009 | C009 | RW |
| 10 | Remote Terminal Address | 2800A | C00A | RW |
| 11 | BIT Start | 2800B | C00B | W |

| Reg No. | BCRTM Register | PHYSICAL ADDRESS | LOGICAL ADDRESS | Read/ Write |
|---|---|---|---|---|
| 12 | Programmed Reset | 2800C | C00C | W |
| 13 | RT Timer Reset | 2800D | C00D | W |
| 14 | Bus Monitor Control | 2800E | C00E | RW |
| 15 | Reserved | 2800F | C00F | ---- |
| 16 | Monitor Selected RT Addr 00-15 | 28010 | C010 | RW |
| 17 | Monitor Selected RT Addr 16-31 | 28011 | C011 | RW |

Opcode 901F Hex: The ***Write BCRTM Register*** command is a three word command that will write one register from the BC chipset. The previous table defines the registers by number used in the parameter DW2 for this write command. Consideration must also be given to the register selected; insuring writing to it is allowable. Parameter DW3 contains the data to be written into the specific BCRTM register.

### 3.10. Named Table Load Commands (TYPE 14)

Opcode E000 Hex: is SPARE and not used and all others in the range E007 Hex to E01F Hex are SPARE

#### 3.10.1. Memory Scrub Table Load Command

Opcode E001 Hex: - ***Memory Scrub Table Load*** is conducted in background operations to correct Single Bit Error (SBE) memory locations that may not normally be read or written frequently. Opcode E001 is a seven (7) data word command and will upload the Memory Scrub table as defined below:

**TABLE 3.10.1-1 - Memory Scrub Table Load Command Example**

| | | | |
|---|---|---|---|
| DW1 | OPCODE | E001 Hex | Memory Scrub Table Load |
| DW2 | Start Index | 0..19 | Which Entry Item |
| DW3 | Enabled | 0-False/8000-True | Hex |
| DW4,5 | Start Address | 0..2_7FFF Hex* | Start Memory Address (2 wds) |
| DW6,7 | End Address | 0..2_7FFF Hex* | End Memory Address (2 wds) |

* Addresses in Memory tables are 20-bits left justified.

#### 3.10.2. Memory Checksum Table Load Command

Opcode E002 Hex: - The ***Memory Checksum Table Load*** command is conducted in background operations to test for bad memory locations that may not normally be read or written frequently. Opcode E002 is an eight (8) word command and will upload the Memory Checksum table as defined in the table below:

**TABLE 3.10.2-1 - Memory Checksum Table Load Command Example**

| | | | |
|---|---|---|---|
| DW1 | OPCODE | E002 Hex | Memory Checksum Table Load |
| DW2 | Start Index | 0..19 | Which Entry Item |
| DW3 | Enabled | 0-False/8000-True | Hex |
| DW4,5 | Start Address | 0..2_7FFF Hex* | Start Memory Address (2 wds) |
| DW6,7 | End Address | 0..2_7FFF Hex* | End Memory Address (2 wds) |
| DW8 | Exp Checksum | 0..FFF Hex | |

* Addresses in Memory tables are 20-bits left justified.

### 3.10.3. MHS Telemetry Major Schedule Load Command

Opcode E003 Hex: - The ***MHS Telemetry Major Schedule Load*** Command is the method of changing the processing of the MHS Telemetry to the MIU. It specifies telemetry data via the MIL-STD-1553B Bus for the entire major frame. Opcode E003 Hex will upload the Memory Address of the Data to be placed in slots 0 to 1999. The default data is defined and initialized in source file"Telemetry_Processing_UTD_Pkg_.Ada" as "MHS_Major_Schedule" organized as 80 blocks of 25 address pointers making a total of 2000 addresses pointing to items in MIU memory. Use of this command should be extremely rare and requires a serious study of the MIU / MHS telemetry that goes beyond the scope of this document.

**TABLE 3.10.3-1- MHS Telemetry Major Schedule Load Command**

| | | | |
|---|---|---|---|
| DW1 | OPCODE | E003 Hex | MHS Telemetry Major Schedule Load |
| DW2 | Start Index | 0..1999 | Which Entry Item |
| DW3 | Address | 0..FFFF Hex | Memory Address of TLM Data |

### 3.10.4. TIP Telemetry Major Schedule Table Load

Opcode E004 Hex: - The ***TIP Telemetry Major Schedule Table Load*** command is the method of modifying the MIU/MHS TIP Telemetry. Opcode E004 Hex will upload the Memory Address of the Data to be placed in slot 0..39.

**TABLE 3.10.4-1- TIP Telemetry Major Schedule Command**

| | | | |
|---|---|---|---|
| DW1 | OPCODE | E004 Hex | TIP TLM Major Schedule Table Load |
| DW2 | Start Index | 0..39 | Which Entry Item |
| DW3 | Address | 0..FFFF Hex | Memory Address of TLM Data |

### 3.10.5. TIP Engineering Telemetry Major Schedule Load Command

Opcode E005 Hex: - The ***TIP Engineering Telemetry Major Schedule Load*** Command is the method of changing the TIP Engineering Telemetry schedule. Opcode E005 Hex will upload the Memory Address of the Data to be placed in slot 0..39.

**TABLE 3.10.5-1 - TIP Engineering Telemetry Major Schedule Load Command**

| | | | |
|---|---|---|---|
| DW1 | OPCODE | E005 Hex | TIP Engineering TLM Major Schedule Load |
| DW2 | Start Index | 0..39 | Which Entry Item |
| DW3 | Address | 0..FFFF Hex | Memory Address of TLM Data |

### 3.10.6. AIP Telemetry Major Schedule Load Command

Opcode E006 Hex: - The ***AIP Telemetry Major Schedule Load*** Command is the method of modifying the MIU/MHS AIP Telemetry schedule. Opcode E006 Hex will upload the Memory Address of the Data to be placed in slot 0..239.

**TABLE 3.10.6-1 - AIP Telemetry Major Schedule Load Command Example**

| | | | |
|---|---|---|---|
| DW1 | OPCODE | E006 Hex | AIP Telemetry Major Schedule Load |
| DW2 | Start Index | 0..239 | Which Entry Item |
| DW3 | Address | 0..FFFF Hex | Memory Address of TLM Data |

### 3.11. General Memory Load Command (TYPE 15)

Opcode F000 Hex: is SPARE and not used.

Opcode F001 Hex: The ***General Memory Load*** Command is a variable word length command. The Command Format is depicted below.

**TABLE 3.11-1 – General Memory Load Command**

| | | | |
|---|---|---|---|
| DW1 | OPCODE | F001 Hex | Comments |
| DW2 | MS Target Address | 0..2FFF Hex | Top Memory Address of Load |
| DW3 | LS Target Address | 0..2FFF Hex | Bottom Memory Address |
| DW4 | DATA | | |
| DW5 | DATA | | |
| ... | | | |
| DW n+3 * | DATA | | |

* n = number of data words to be loaded with one command where 1 < n < 125

# 4. MIU TELEMETRY

## 4.1. Bootstrap Telemetry

While in Bootstrap Mode, MIU telemetry is inserted into TIP TLM byte 102 and into AIP TLM bytes 6-7 and bytes 48-101. The Command verification (CV) word is returned in TIP Telemetry byte 102 in minor frames 7-8, 23-24, etc. and in AIP bytes 52-53 as shown in this table below. The MIU cannot command the MHS or request serial MHS telemetry while in Bootstrap mode. Only the three analog MHS survival temperatures are available in TLM since they are hardwired through the MIU box. However, the MIU can read (dump) memory RAM or ROM into AIP bytes 60-101 as shown in the table below.

**TABLE 4.1-1 - Bootstrap Telemetry Frame TIP & AIP**

| *TIP BYTE 102 OF TIP MINOR FRAME COUNT* | | | | | *AIP BYTE* | *BITS* | *DESCRIPTION* | *TLM* *TIP* | *TLM* *AIP* | *MIU SUBSYS* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 17 | 33 | 49 | 65 | 6 | 0-5 | SYNC Pattern 1 – 101010 | MIU500 | MIU80 | TLM |
| | | | | | | 6-7 | MIU H/W ID – 00 | MIU501 | MIU78 | |
| 2 | 18 | 34 | 50 | 66 | 7 | 0-3 | SYNC Pattern 2 – 1010 | MIU502 | MIU81 | |
| | | | | | | 4-7 | MIU Bootstrap Minor Cycle Count (0-15) | MIU503 | MIU82 | |
| 3-4 | 19-20 | 35-36 | 51-52 | 67-68 | 48-49 | 0-15 | MIU CPU Fault Register | MIU504 | MIU83 | MIU |
| 5-6 | 21-22 | 37-38 | 53-54 | 69-70 | 50-51 | 0-15 | Hardware Status Word | MIU505 | MIU84 | H/W |
| 7-8 | 23-24 | 39-40 | 55-56 | 71-72 | 52-53 | 0-15 | Command Verification Status Or Reply Message (see Table 4.1.2-1) | MIU506 | MIU85 | CV |
| 9-10 | 25-26 | 41-42 | 57-58 | 73-74 | 54-55 | 0 | One Byte Read From TIP FIFO | MIU511 | MIU86 | FIFO Status |
| | | | | | | 1 | TIP FIFO is Empty | MIU512 | MIU87 | |
| | | | | | | 2 | TIP FIFO is Full | MIU513 | MIU88 | |
| | | | | | | 3 | 56 Bytes Read from AIP FIFO | MIU514 | MIU89 | |
| | | | | | | 4 | AIP FIFO is Empty | MIU515 | MIU90 | |
| | | | | | | 5 | AIP FIFO is Full | MIU516 | MIU91 | |
| | | | | | | 6-15 | Remaining Word Count in Current CIU Xfer | MIU517 | MIU92 | CIU |
| 11-12 | 27-28 | 43-44 | 59-60 | 75-76 | 56-57 | 0-15 | Bootstrap Checksum | MIU518 | MIU93 | MIU |
| 13-14 | 29-30 | 45-46 | 61-62 | 77-78 | 58-59 | 0-7 | CSN for Command in Progress | MIU519 | MIU94 | CMD Status |
| | | | | | | 8 | Invalid Destination | MIU520 | MIU95 | |
| | | | | | | 9 | Invalid OPCODE | MIU521 | MIU96 | |
| | | | | | | 10 | Invalid No. of Data Words | MIU522 | MIU97 | |
| | | | | | | 11 | Invalid Range/Address | MIU523 | MIU98 | |
| | | | | | | 12-13 | 00-Idle 10-In Progress 01-Initiated 11-Not Used | MIU524 | MIU99 | |
| | | | | | | 14-15 | 00-RAM Dump 01-RAM Dump (Add 10000 to Next Word) 10-RAM Dump (Add 20000 to Next Word) 11-ROM Dump | MIU525 | MIU73 | Mem. Dump |
| 15-16 | 31-32 | 47-48 | 63-64 | 79-0 | 60-61 | 0-15 | Physical Address of Memory Dump | MIU526 | MIU74 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | 62-101 | 0-15 | 40 Bytes of Dump Data (AIP Only) | N/A | MIU600 thru MIU619 | |

### 4.1.1. Bootstrap Command Verification Messages

Bootstrap Command Verification (CV) Status is found in TIP telemetry byte 102 of minor frames 7-8, 23-24, etc., and in AIP bytes 52-53 as shown in the previous table. This is one of the most important items found in Bootstrap telemetry since it will indicate the validity and status of the commands sent to the MIU.

The format for CV Status is depicted below in Table 4.1.2-1 as a one word message with Bit-0 (MIU52) set to zero (0). If Bit-0 (MIU52) is set to one (1) then it is not a CV Status word but a Reply Message, one of the five types shown in the next Table 4.1.2-2. Bootstrap CV Status communicates errors, warnings, and the command sequence number of the last command in a single CV Status word. Both Warnings (bits 4-7) and Errors (bits 1-3) may appear in a single CV Status word.

| BITS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MIU52 | MIU53 | | | MIU54 | | | | MIU55 | | | | | | | |
| | 0 | ERROR | | | WARNINGS | | | | COMMAND SEQUENCE NUMBER | | | | | | | |

<u>NOTE</u>: Bit 0 must = 0 from MIU 506 (TIP) or MIU 85 (AIP) or MIU 52 = 0 to be this CV status word.
If Bit 0 =1, reference Reply Message Formats.

| | | |
|---|---|---|
| ERRORS: | 0 | No Error |
| | 1 | Ground checksum for command does not match the calculated |
| | 2 | The OPCODE for an MIU command is invalid |
| | 3 | The Command Destination is not MIU |
| | 4 | There are too many or too few data words for the associated OPCODE (length error) |
| | 5 | The Address or Range for the associated OPCODE is out-of-bounds |
| | 6 | The previously requested memory dump has been terminated |
| | 7 | Undefined |
| WARNINGS: | 0 | No Warnings |
| | 1 | Out of sequence CSN encountered |
| | 2 | This CV Queue has overflowed |
| | 3 | Out Of Sequence CSN & CV Queue overflowed |

**TABLE 4.1.2-1 – Bootstrap CV Error and Warning Codes**

When bit-0 is set to one (1) then the Reply Message is being sent by Bootstrap software. The following table shows all formats of the reply word(s). These are 3, 4, or 8 total words sent in the same AIP or TIP locations but with different data and purpose. These words will be sent 1 word per 2 minor frames until all words needed for each type reply are transmitted.

**TABLE 4.1.2-2 – Bootstrap Mode Reply Message Formats**

| Data Word (DW) | Type (0) Read I/O | Type (1) Write I/O | Type (2) Checksum RAM | Type (3) Checksum ROM | Type (7) CV Queue is Idle |
|---|---|---|---|---|---|
| 0 | 8200 Hex | 9200 Hex | A300 Hex + SA MSB + EA MSB | B300 Hex | F000 Hex + Last CSN Echoed |
| 1 | MIU 1750A I/O Port Address | MIU 1750A I/O Port Address | 16 bits LSB Start Address | 1 + Physical Start Address | N/A |
| 2 | I/O Data | I/O Data (Echoed) | 16 bits LSB End Address | Physical End Address | N/A |
| 3 | 0 (0200 if Overflow) + CSN | 0 (0200 if Overflow) + CSN | Checksum | Checksum | N/A |
| 4 | N/A | N/A | 0 (0200 if overflow) + CSN | 0 (0200 if Overflow) + CSN | N/A |

Legend: SA MSB – Start Address Most Significant Bits,
EA MSB – End Address Most Significant Bits,
LSB - Least Significant Bits
CSN – Command Sequence Number

### 4.2. TIP Telemetry

TIROS Information Processor (TIP) Telemetry from the MIU is supplied as 8-bits in Byte 102 each minor frame. It supplies telemetry header, command verification words, and additional housekeeping information from the MIU and MHS. TIP Telemetry from MIU is supported in three modes, Normal, Engineering, and Very Slow Dump Mode.

#### 4.2.1. TIP Normal Telemetry Frame

For TIP Normal mode, reference Table 4.2.1-1, the Telemetry Frame Header is output in minor frames one and two (1 & 2) providing the Telemetry Mode, TIP Engineering Mode Enabled flag, MIU ID, and Minor Cycle Count. This is followed in minor frames three and four by the Command Verification Word. Current Telemetry Mode displays Normal, Fast Dump, Slow Dump, Very Slow Dump, and Bus Engineering modes for the MIU.

Only Normal, Very Slow Dump, and Bus Engineering Telemetry Modes affect the TIP downlink. Minor frames five and six will provide the Bus Controller modes, TLM, HK Dump, or SCI Dump modes. Next is information from Scan Period 2 (previous reporting period) from the MHS CCSDS header including Whole Time, Fractional Time, and Housekeeping Packet in minor frames 7-10, 11-12, and 13-28 respectively. This is followed by a CV word then the HK Failed Collection Count in minor frames 29-30, 31-32.

Subsequently, Scan Period 0 includes information similar to Scan Period 2 CCSDS information in minor frames 33-54. Another CV Word and HK Valid Packet Counts are next and finally Scan Period 1 data fills the rest of the major frame.

**TABLE 4.2.1-1 - MIU TIP Telemetry Frame – Normal**

| *TIP MINOR FRAME COUNT* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|
| 1 | 0-1 | RESERVED | | | | TLM |
| | 2-4 | TELEMETRY MODE | MIU 1 | 000<br>001<br>010<br>011<br>100<br>101<br>110<br>111 | Normal<br>Fast Dump<br>Slow Dump<br>Very Slow Dump<br>Bus Engr Mode<br>Undefined<br>Undefined<br>Undefined | |
| | 5 | ** TIP ENGINEERING FRAME ENABLED | MIU 2 | 0/1 | 0=DISABLED | |
| | 6-7 | MIU ID | MIU 3 | 00<br>01<br>11 | MIU 1<br>MIU 2<br>SINGLE MIU | MIU H/W |
| 2 | 0-7 | MIU MINOR CYCLE NUMBER | MIU 4 | HEX | INTEGER | TIME |
| 3-4 | 0-15 | COMMAND VERIFICATION WORD | MIU 5 | HEX | Ref CV Wrd Definition | CMD |
| 5-6 | 0-13 | RESERVED | | | | BUS CONTROL |
| | 14-15 | BUS CONTROLLER MODE | MIU 6 | 00<br>01<br>10<br>11 | TLM<br>HK DUMP<br>SCI DUMP<br>UNDEFINED | |
| 7-10 | 0-31 | * SCAN PERIOD 2 COARSE TIME | MIU 7, 8 | SEC | LSB=1 second | MHS HK |
| 11-12 | 0-15 | * SCAN PERIOD 2 FINE TIME | MIU 9 | SEC | LSB-2^-16seconds | |
| 13-28 | 0-127 | * SCAN PERIOD 2 HOUSEKEEPING PACKET | | | 16 Bytes HK/pkt | |
| 29-30 | 0-15 | COMMAND VERIFICATION WORD | MIU 5 | HEX | REF TBL 2.5.1-1 | CMD |
| 31-32 | 0-15 | HK FAILED COLLECTION COUNT | MIU 10 | HEX | INTEGER | BUS |
| 33-36 | 0-31 | SCAN PERIOD 0 WHOLE TIME | MIU 7, 8 | SEC | LSB=1 second | MHS HK |
| 37-38 | 0-15 | SCAN PERIOD 0 FRACTIONAL TIME | MIU 9 | SEC | LSB-2^-16second | |
| 39-54 | 0-127 | SCAN PERIOD 0 HOUSEKEEPING PACKET | | | 16 Bytes HK/pkt | |
| 55-56 | 0-15 | COMMAND VERIFICATION WORD | MIU 5 | HEX | REF TBL 2.5.1-1 | CMD |
| 57-58 | 0-15 | HK VALID PACKETS COUNT | MIU 11 | HEX | | BUS |
| 59-62 | 0-31 | SCAN PERIOD 1 WHOLE TIME | MIU 7, 8 | SEC | LSB=1 second | MHS HK |
| 63-64 | 0-15 | SCAN PERIOD 1 FRACTIONAL TIME | MIU 9 | SEC | LSB-2^-16seconds | |
| 65-79,0 | 0-128 | SCAN PERIOD 1 HOUSEKEEPING PACKET | | | 16 Bytes HK/pkt | |

* Scan Period 2 is reporting prior 8-second frame (n-1)

** When TIP Engr Frame is enabled, disregard MIU 1 indications of "Normal" in this mode.

### 4.2.2. TIP Engineering Telemetry Frame

TIP Engineering Frame Telemetry is used for diagnostics on the MIU and MIL-STD-1553B Bus operation. It begins with the standard Telemetry Frame Header in minor cycle 1 followed by the major cycle number (TIP minor frames 3-6) and the Command Verification Word (minor frames 7-8.) Various Error Counters are included in minor frames 9-22.

The rest of the major frame is filled with Bus data regarding current states and modes, retry counters, failed operation counters, error table indices and other data on the MIL-STD-1553B bus. See the Table on the MIU TIP Engineering Frame below for a full definition of this mode.

Subsequently, Scan Period 0 includes information similar to Scan Period 2 CCSDS information in minor frames 33-54. Another CV Word and HK Valid Packet Counts are next and finally Scan Period 1 data fills the rest of the major frame.

**TABLE 4.2.1-1 - MIU TIP Telemetry Frame – Normal**

| *TIP MINOR FRAME COUNT* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|
| 1 | 0-1 | RESERVED | | | | TLM |
| | 2-4 | TELEMETRY MODE | MIU 1 | 000<br>001<br>010<br>011<br>100<br>101<br>110<br>111 | Normal<br>Fast Dump<br>Slow Dump<br>Very Slow Dump<br>Bus Engr Mode<br>Undefined<br>Undefined<br>Undefined | |
| | 5 | ** TIP ENGINEERING FRAME ENABLED | MIU 2 | 0/1 | 0=DISABLED | |
| | 6-7 | MIU ID | MIU 3 | 00<br>01<br>11 | MIU 1<br>MIU 2<br>SINGLE MIU | MIU H/W |
| 2 | 0-7 | MIU MINOR CYCLE NUMBER | MIU 4 | HEX | INTEGER | TIME |
| 3-4 | 0-15 | COMMAND VERIFICATION WORD | MIU 5 | HEX | Ref CV Wrd Definition | CMD |
| 5-6 | 0-13 | RESERVED | | | | BUS CONTROL |
| | 14-15 | BUS CONTROLLER MODE | MIU 6 | 00<br>01<br>10<br>11 | TLM<br>HK DUMP<br>SCI DUMP<br>UNDEFINED | |
| 7-10 | 0-31 | * SCAN PERIOD 2 COARSE TIME | MIU 7, 8 | SEC | LSB=1 second | MHS HK |
| 11-12 | 0-15 | * SCAN PERIOD 2 FINE TIME | MIU 9 | SEC | LSB-2^-16seconds | |
| 13-28 | 0-127 | * SCAN PERIOD 2 HOUSEKEEPING PACKET | | | 16 Bytes HK/pkt | |
| 29-30 | 0-15 | COMMAND VERIFICATION WORD | MIU 5 | HEX | REF TBL 2.5.1-1 | CMD |
| 31-32 | 0-15 | HK FAILED COLLECTION COUNT | MIU 10 | HEX | INTEGER | BUS |
| 33-36 | 0-31 | SCAN PERIOD 0 WHOLE TIME | MIU 7, 8 | SEC | LSB=1 second | MHS HK |
| 37-38 | 0-15 | SCAN PERIOD 0 FRACTIONAL TIME | MIU 9 | SEC | LSB-2^-16second | |
| 39-54 | 0-127 | SCAN PERIOD 0 HOUSEKEEPING PACKET | | | 16 Bytes HK/pkt | |
| 55-56 | 0-15 | COMMAND VERIFICATION WORD | MIU 5 | HEX | REF TBL 2.5.1-1 | CMD |
| 57-58 | 0-15 | HK VALID PACKETS COUNT | MIU 11 | HEX | | BUS |
| 59-62 | 0-31 | SCAN PERIOD 1 WHOLE TIME | MIU 7, 8 | SEC | LSB=1 second | MHS HK |
| 63-64 | 0-15 | SCAN PERIOD 1 FRACTIONAL TIME | MIU 9 | SEC | LSB-2^-16seconds | |
| 65-79,0 | 0-128 | SCAN PERIOD 1 HOUSEKEEPING PACKET | | | 16 Bytes HK/pkt | |

* Scan Period 2 is reporting prior 8-second frame (n-1)

** When TIP Engr Frame is enabled, disregard MIU 1 indications of "Normal" in this mode.

### 4.2.2. TIP Engineering Telemetry Frame

TIP Engineering Frame Telemetry is used for diagnostics on the MIU and MIL-STD-1553B Bus operation. It begins with the standard Telemetry Frame Header in minor cycle 1 followed by the major cycle number (TIP minor frames 3-6) and the Command Verification Word (minor frames 7-8.) Various Error Counters are included in minor frames 9-22.

The rest of the major frame is filled with Bus data regarding current states and modes, retry counters, failed operation counters, error table indices and other data on the MIL-STD-1553B bus. See the Table on the MIU TIP Engineering Frame below for a full definition of this mode.

## TABLE 4.2.2-1 - MIU TIP Telemetry Frame - Engineering

| *TIP MINOR FRAME* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|
| 1 | 0-1 | RESERVED | | | | |
| | 2-4 | * TELEMETRY MODE | MIU 1 | 000<br>001<br>010<br>011<br>100<br>101<br>110<br>111 | Normal<br>Fast Dump<br>Slow Dump<br>Very Slow Dump<br>Bus Engr Mode<br><br>Undefined<br>Undefined | TLM |
| | 5 | * TIP ENGINEERING FRAME ENABLED | MIU 2 | 0/1 | 1 - Enabled | |
| | 6-7 | MIU ID | MIU 3 | 00<br>01<br>11 | MIU 1<br>MIU 2<br>SINGLE MIU | MIU H/W |
| 2 | 0-7 | MIU MINOR CYCLE NUMBER | MIU 4 | HEX | INTEGER | TIME |
| 3-6 | 0-31 | MAJOR CYCLE NUMBER | MIU 12.1 | HEX | INTEGER | |
| 7-8 | 0-15 | COMMAND VERIFICATION WORD | MIU 5 | HEX | REF TBL 2.5.1-1 | CMD |
| 9-10 | 0-15 | SINGLE BIT ERROR COUNT | MIU 14 | HEX | INTEGER | MIU MEM |
| 11-12 | 0-15 | MEMORY CHECKSUM ERROR COUNT | MIU 15 | HEX | INTEGER | |
| 13-14 | 0-15 | MINOR CYCLE ERROR COUNT | MIU 16 | HEX | INTEGER | |
| 15-16 | 0-15 | UNHANDLED INTERRUPT COUNT | MIU 17 | HEX | INTEGER | |
| 17-18 | 0-15 | MACHINE ERROR COUNT | MIU 18 | HEX | INTEGER | |
| 19-20 | 0-15 | EXCEPTION OCCURRED COUNT | MIU 19 | HEX | INTEGER | |
| 21-22 | 0-15 | BC UNEXPLAINED EXCEPTION COUNT | MIU 20 | HEX | INTEGER | 1553 Bus |
| 23-24 | 0-13 | RESERVED | | | | |
| | 14-15 | BUS CONTROLLER STATE | MIU 21 | 00<br>01<br>10<br>11 | OFF<br>ENABLING<br>ON<br>DISABLING | |
| 25-26 | 0-13 | RESERVED | | | | |
| | 14-15 | BUS CONTROLLER MODE | MIU 6 | 00<br>01<br>10<br>11 | TLM<br>HK DUMP<br>SCI DUMP<br>UNDEFINED | |
| 27-28 | 0-12 | RESERVED | | | | |
| | 13 | LAST BUS USED | MIU 22 | 0/1 | Bus A =1; B = 0 | |
| | 14 | GROUND PREFERRED BUS | MIU 23 | 0/1 | Bus A =1; B = 0 | |
| | 15 | MIU PREFERRED BUS | MIU 24 | 0/1 | Bus A =1; B = 0 | |
| 29-30 | 0-14 | RESERVED | | | | |
| | 15 | BUS OVERRUN OCCURRED | MIU 25 | 0/1 | No=0; Yes=1 | |
| 31-32 | 0-15 | BCRTM INTERRUPT LOG LIST POINTER | MIU 26 | HEX | INTEGER | |
| 33-34 | 0-15 | HK FAILED COLLECTION COUNT | MIU 10 | HEX | INTEGER | |
| 35-36 | 0-15 | HK REQUEST RETRIES COUNT | MIU 27 | HEX | INTEGER | |
| 37-38 | 0-15 | HK TVW RETRIES COUNT | MIU 28 | HEX | INTEGER | |
| 39-40 | 0-15 | HK COLLECTION RETRIES COUNT | MIU 29 | HEX | INTEGER | |
| 41-42 | 0-15 | HK CCSDS VALID PACKETS COUNT | MIU 30 | HEX | INTEGER | |
| 43-44 | 0-15 | HK 1553B ERROR TABLE INDEX | MIU 31 | HEX | INTEGER | |

* When TIP Engineering Frame is enabled, disregard MIU 1 indications of "Normal" in this mode.

## TABLE 4.2.2-1 - MIU TIP Telemetry Frame – Engineering (Cont.)

| *TIP MINOR FRAME COUNT* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *UBSYSTEM* |
|---|---|---|---|---|---|---|
| 45-46 | 0-15 | SCI FAILED COLLECTION COUNT | MIU 32 | HEX | INTEGER | |
| 47-48 | 0-15 | SCI REQUEST RETRIES COUNT | MIU 33 | HEX | INTEGER | |
| 49-50 | 0-15 | SCI TVW RETRIES COUNT | MIU 34 | HEX | INTEGER | |
| 51-52 | 0-15 | SCI COLLECTION RETRIES COUNT | MIU 35 | HEX | INTEGER | |
| 53-54 | 0-15 | SCI CCSDS VALID PACKETS COUNT | MIU 36 | HEX | INTEGER | |
| 55-56 | 0-15 | SCI 1553B ERROR TABLE INDEX | MIU 37 | HEX | INTEGER | 1553 Bus BCR1 |
| 57-58 | 0-15 | SKIPPED MHS COMMANDS COUNT | MIU 38 | HEX | INTEGER | |
| 59-60 | 0-15 | SUCCESSFUL MHS COMMANDS COUNT | MIU 39 | HEX | INTEGER | |
| 61-62 | 0-15 | CMD MACHINE RESET COUNT | MIU 40 | HEX | INTEGER | |
| 63-64 | 0-15 | CMD MACHINE RETRIES COUNT | MIU 41 | HEX | INTEGER | |
| 65-66 | 0-15 | CMD 1553B ERROR TABLE INDEX | MIU 42 | HEX | INTEGER | |
| 67-68 | 0-15 | PENDING MHS COMMAND COUNT | MIU 43 | HEX | INTEGER | |
| 69-70 | 0-15 | MISC TRANSACTIONS FAIL COUNT | MIU 44 | HEX | INTEGER | |
| 71-72 | 0-15 | MISC TRANSACTIONS SUCCESS COUNT | MIU 45 | HEX | INTEGER | |
| 73-74 | 0-15 | MISC MACHINE RESET COUNT | MIU 46 | HEX | INTEGER | |
| 75-76 | 0-15 | MISC MACHINE RETRIES COUNG | MIU 47 | HEX | INTEGER | |
| 77-78 | 0-15 | MISC MACHINE 1553B ERROR TABLE INDEX | MIU 48 | HEX | INTEGER | |
| 79 | 0-7 | WRAP TEST FAIL COUNT | MIU 49 | HEX | INTEGER | |
| 0 | 0-7 | BIT FAIL COUNT | MIU 50 | HEX | INTEGER | |

### 4.2.3. Very Slow Dump Mode

The Very Slow Dump begins with the standard Telemetry Frame Header in minor cycle 1 including the MIU minor cycle number (minor frame 2.) The Memory Dump begins in minor frame 3 and continues until 39 words are completed. This mode would rarely be used since only one 8-bit byte is dumped per TIP minor frame (0.1 sec), which for a download of 39 words would take approximately 8 minutes.

## TABLE 4.2.3-1 - MIU TIP Telemetry Frame - Very Slow Dump Mode

| *TIP MINOR FRAME CNT* | *BITS* | *ESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *IIU UBSYSTEM* |
|---|---|---|---|---|---|---|
| 1 | 0-1 | RESERVED | | | | |
| | 2-4 | TELEMETRY MODE | MIU 1 | 000<br>001<br>010<br>011<br>100<br>101<br>110<br>111 | Normal NORM<br>Fast Dump FADU<br>Slow Dump SLDU<br>Very Slow Dump VSDU<br>Bus Engr Mode BEM<br>Undefined UNDF<br>Undefined<br>Undefined | TLM |
| | 5 | TIP ENGINEERING FRAME ENABLED | MIU 2 | 0/1 | 0 - Disabled | |
| | 6-7 | MIU ID | MIU 3 | 00<br>01<br>11 | MIU 1<br>MIU 2<br>SINGLE MIU | MIU H/W |
| 2 | 0-7 | MIU MINOR CYCLE | MIU 4 | HEX | INTEGER | TIME |
| 3-79,0 | 0-7 | 39 WORDS OF MEMORY DUMP DATA | | HEX | 8 Bit wds/Minor Frame | MEM UTIL |

### 4.2.4. AIP Bytes 6 And 7

All AIP telemetry includes the Telemetry Frame Header data in words 6-7 of every minor frame. This is the same data and format as in the TIP Telemetry described above and in the table below.

**TABLE 4.2.4-1 - MIU AIP Bytes 6 and 7**

| *MIU MINOR CYCLE* | *BYTE* | *BITS* | *ESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|---|
| All | 6 | 0-1 | RESERVED | | | | TLM |
| | | 2-4 | TELEMETRY MODE | MIU 75<br>MIU 76 | 000<br>001<br>010<br>011<br>100<br>101<br>110<br>111 | Normal NORM<br>Fast Dump FADU<br>Slow Dump SLDU<br>Very Slow Dump VSDU<br>Bus Eng Mode BEM<br>Undefined UNDF<br>Undefined<br>Undefined | |
| | | 5 | TIP ENGR FRAME ENABLED | MIU 77 | 0/1 | 1=ENAB 0=DISABLE | |
| | | 6-7 | MIU ID | | 00<br>01<br>11 | MIU 1<br>MIU 2<br>SINGLE MIU | MIU H/W |
| | 7 | 0-7 | MIU MINOR CYCLE | MIU 79 | HEX | INTEGER | TIME |

### 4.2.5. AIP Bytes 48-97 Normal Telemetry Mode

MIU Normal Mode telemetry is included in AIP bytes 48-97. Science Data is organized by minor frame as depicted in the table below:

**TABLE 4.2.5-1 – AIP Normal Mode Telemetry Data**

| MIU Minor Cycle | Data Description |
|---|---|
| 0 | 1553B Bus Data / MHS CCSDS Data (PKT 2) |
| 1-25 | 25 words MHS CCSDS Data (PKT 2) |
| 26 | Last 17 words MHS CCSDS Data / 1553B Data |
| 27 | 1553B Bus Data / MHS CCSDS Data (PKT 0) |
| 28-52 | 25 words MHS CCSDS Data (PKT 0) |
| 53 | Last 17 words MHS CCSDS Data / 1553B Data |
| 54 | 1553B Bus Data / MHS CCSDS Data (PKT 1) |
| 55-79 | 25 words MHS CCSDS Data (PKT 1) |

Reference the following AIP TELEMETRY BYTES 48-97 (NORMAL) Table for full details.

## TABLE 4.2.5-2 - MIU AIP Bytes 48-97 - Normal Telemetry Mode

| *MIU MINOR CYCLE* | *BYTE* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|---|
| 0 | 48-49 | 0 | NIL BUS Trans Enable | MIU 100 | 0/1 | 0=Disable; | 1553 Bus BCRT |
| | | 1 | MISC BUS Trans Enable | MIU 101 | 0/1 | 0=Disable; | |
| | | 2 | HK BUS Trans Enable | MIU 102 | 0/1 | 0=Disable; | |
| | | 3 | SCI BUS Trans Enable | MIU 103 | 0/1 | 0=Disable; | |
| | | 4 | CMD BUS Trans Enable | MIU 104 | 0/1 | 0=Disable; | |
| | | 5-15 | RESERVED | | | | |
| | 50-51 | 0-15 | HK BUS Fail Periods Count | MIU 105 | HEX | | |
| | 52-53 | 0-15 | HK BUS Error Table Index | MIU 106 | HEX | | |
| | 54-55 | 0-15 | SCI BUS Fail Periods Count | MIU 107 | HEX | | |
| | 56-57 | 0-15 | SCI BUS Error Table Index | MIU 108 | HEX | | |
| | 58-59 | 0-15 | BUS SKIPPED CMND Count | MIU 109 | HEX | | |
| | 60-61 | 0-15 | BUS CMND Error Table Index | MIU 110 | HEX | | |
| | 62-63 | 0-15 | MISC BUS Fail Periods Count | MIU 111 | HEX | | |
| | 64-65 | 0-15 | MISC BUS Error Table Index | MIU 112 | HEX | | |
| | 66 | 0-7 | WRAP TEST Failure Count | MIU 113 | HEX | | |
| | 67 | 0-7 | BIT TEST Failure Count | MIU 114 | HEX | | |
| | 68-69 | 0-14 | RESERVED | | | | |
| | | 15 | WRAP TEST Pattn Mod Enable | MIU 115 | 0/1 | 0=Disable; | |
| | 70-71 | 0-15 | BIT Timeouts Count | MIU 116 | HEX | | |
| | 72-73 | 0-15 | BIT Results | MIU 117 | HEX | | |
| | 74-75 | 0-15 | BUS RESET Timeouts Count | MIU 118 | HEX | | |
| | 76-77 | 0-14 | RESERVED | | | | |
| | | 15 | BUS Overrun Occurred | MIU 119 | 0/1 | 0=no; 1=yes | |
| | 78-79 | 0-15 | Last Cmd During Bus Overrun | MIU 120 | HEX | | |
| | 80-81 | 0-12 | RESERVED | | | | |
| | | 13 | LAST BUS USED | MIU 121 | 0/1 | Bus A =1; B = 0 | |
| | | 14 | GROUND PREFERRED BUS | MIU 122 | 0/1 | Bus A =1; B = 0 | |
| | | 15 | MIU PREFERRED BUS | MIU 123 | 0/1 | Bus A =1; B = 0 | |
| | 82-83 | 0-15 | BIT ITERATIONS | MIU 124 | HEX | | |
| | 84-85 | 0-15 | HK BUS REQUEST RETRY LIMIT | MIU 125 | HEX | | |
| | 86-87 | 0-15 | HK TVW RETRY LIMIT | MIU 126 | HEX | | |
| | 88-89 | 0-15 | HK RES RETRY LIMIT | MIU 127 | HEX | | |
| | 90-95 | 0-47 | *CCSDS TIME TAG SCI PKT 2 | MIU 128, 129, 130 | HEX | (LSB=2^-16) | MHS |
| | 96-97 | 0-15 | *FIRST WORD OF SCI PKT 2 | | | | |
| 1-25 | 48-97 | | *NEXT 25 WORDS OF SCI PKT 2 | | | | |
| 26 | 48-81 | | *LAST 17 WORDS OF SCI PKT 2 | | | | |
| | 82-83 | 0 | NIL BUS TRNS ENABLED | MIU 100 | 0/1 | 0=Disable; | 1553 Bus BCRT 2 nd Iteration --> |
| | | 1 | MISC BUS TRNS ENABLED | MIU 101 | 0/1 | 0=Disable; | |
| | | 2 | HK BUS TRNS ENABLED | MIU 102 | 0/1 | 0=Disable; | |
| | | 3 | SCI BUS TRNS ENABLED | MIU 103 | 0/1 | 0=Disable; | |
| | | 4 | CMD BUS TRNS ENABLED | MIU 104 | 0/1 | 0=Disable; | |
| | | 5-15 | RESERVED | | | | |
| | 84-85 | 0-15 | HK BUS FAILED PERIODS COUNT | MIU 105 | HEX | | |
| | 86-87 | 0-15 | HK BUS ERROR TABLE INDEX | MIU 106 | HEX | | |
| | 88-89 | 0-15 | SCI BUS FAILED PERIODS COUNT | MIU 107 | HEX | | |
| | 90-91 | 0-15 | SCI BUS ERROR TABLE INDEX | MIU 108 | HEX | | |
| | 92-93 | 0-15 | BUS SKIPPED COMAND COUNT | MIU 109 | HEX | | |
| | 94-95 | 0-15 | BUS CMND ERROR TABLE INDEX | MIU 110 | HEX | | |

| MINOR CYCLE | BYTE | BITS | DESCRIPTION | TLM | STATE | DEFINITION | |
|---|---|---|---|---|---|---|---|
| | 96-97 | 0-15 | MISC BUS FAIL PERIODS COUNT | MIU 111 | HEX | | |
| 27 | 48-49 | 0-15 | MISC BUS ERROR TABLE INDEX | MIU 112 | HEX | | |
| | 50 | 0-7 | WRAP TEST FAILURE COUNT | MIU 113 | HEX | | |
| | 51 | 0-7 | BIT TEST FAILURE COUNT | MIU 114 | HEX | | |
| | 52-53 | 0-14 | RESERVED | | | | |
| | | 15 | WRAP TEST PATT MOD ENABLED | MIU 115 | 0/1 | 0=Disable; | |
| | 54-55 | 0-15 | BIT TIMOUTS COUNT | MIU 116 | HEX | | |
| | 56-57 | 0-15 | BIT RESULTS | MIU 117 | HEX | | |
| | 58-59 | 0-15 | BUS RESET TIMEOUTS COUNT | MIU 118 | HEX | | |
| | 60-61 | 0-14 | RESERVED | | | | |
| | | 15 | BUS OVERRUN OCCURRED | MIU 119 | 0/1 | 0=no; 1=yes | |
| | 62-63 | 0-15 | LAST CMND During BUS Overrun | MIU 120 | HEX | | |
| | 64-65 | 0-12 | RESERVED | | | | |
| | | 13 | LAST BUS USED | MIU 121 | 0/1 | Bus A =1; B = 0 | |
| | | 14 | GROUND PREFERRED BUS | MIU 122 | 0/1 | Bus A =1; B = 0 | |
| | | 15 | MIU PREFERRED BUS | MIU 123 | 0/1 | Bus A =1; B = 0 | |
| | 66-67 | 0-15 | RESET ITERATIONS | MIU 131 | HEX | | |
| | 68-69 | 0-15 | SCI BUS REQUEST RETRY LIMIT | MIU 132 | HEX | | |
| | 70-71 | 0-15 | SCI TVW RETRY LIMIT | MIU 133 | HEX | | |
| | 72-73 | 0-15 | SCI RES RETRY LIMIT | MIU 134 | HEX | | |
| | 74-79 | 0-47 | CCSDS TIMETAG SCI PKT 0 | MIU 128, 129, 130 | HEX | (LSB=2^-16) | MHS |
| | 80-97 | | FIRST 9 WORDS OF SCI PKT 0 | | | | |
| 28-52 | 48-97 | | NEXT 25 WORDS OF SCI PKT 0 | | | | |
| 53 | 48-65 | | LAST 9 WORDS OF SCI PKT 0 | | | | MHS |
| | 66-67 | 0 | NIL BUS TRNS ENABLED | MIU 100 | 0/1 | 0=Disable; | 3 rd iteration ~> 1553 Bus BCRT |
| | | 1 | MISC BUS TRNS ENABLED | MIU 101 | 0/1 | 0=Disable; | |
| | | 2 | HK BUS TRNS ENABLED | MIU 102 | 0/1 | 0=Disable; | |
| | | 3 | SCI BUS TRNS ENABLED | MIU 103 | 0/1 | 0=Disable; | |
| | | 4 | CMD BUS TRNS ENABLED | MIU 104 | 0/1 | 0=Disable; | |
| | | 5-15 | RESERVED | | | | |
| | 68-69 | 0-15 | HK BUS Failed Periods Count | MIU 105 | HEX | | |
| | 70-71 | 0-15 | HK BUS Error Table Index | MIU 106 | HEX | | |
| | 72-73 | 0-15 | SCI BUS Failed Periods Count | MIU 107 | HEX | | |
| | 74-75 | 0-15 | SCI BUS Error Table Index | MIU 108 | HEX | | |
| | 76-77 | 0-15 | BUS Skipped Command Count | MIU 109 | HEX | | |
| | 78-79 | 0-15 | BUS Cmd Error Table Index | MIU 110 | HEX | | |
| | 80-81 | 0-15 | MISC BUS Failed Periods Count | MIU 111 | HEX | | |
| | 82-83 | 0-15 | MISC BUS Error Table Index | MIU 112 | HEX | | |
| | 84 | 0-7 | WRAP TEST Failure Count | MIU 113 | HEX | | |
| | 85 | 0-7 | BIT TEST FAILURE COUNT | MIU 114 | HEX | | |
| | 86-87 | 0-14 | RESERVED | | | | |
| | | 15 | WRAP TEST Pattn Mod Enabled | MIU 115 | 0/1 | 0=Disable; | |
| | 88-89 | 0-15 | BIT TIMEOUTS COUNT | MIU 116 | HEX | | |
| | 90-91 | 0-15 | BIT RESULTS | MIU 117 | HEX | | |
| | 92-93 | 0-15 | BUS RESET Timeouts Count | MIU 118 | HEX | | |
| | 94-95 | 0-14 | RESERVED | | | | |
| | | 15 | BUS OVERRUN OCCURRED | MIU 119 | 0/1 | 0=no; 1=yes | |
| | 96-97 | 0-15 | LAST CMD During BUS Overrun | MIU 120 | HEX | | |
| 54 | 48-49 | 0-12 | RESERVED | | | | |
| | | 13 | LAST BUS USED | MIU 121 | 0/1 | Bus A =1; B = 0 | |
| | | 14 | GROUND PREFERRED BUS | MIU 122 | 0/1 | Bus A =1; B = 0 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 15 | MIU PREFERRED BUS | MIU 123 | 0/1 | Bus A =1; B = 0 | |
| | 50-51 | 0-15 | BCRTM Last INTR LOG List Pntr | MIU 135 | HEX | | |
| | 52-53 | 0-15 | CMD RETRY LIMIT | MIU 136 | HEX | | |
| | 54-55 | 0-15 | MISC RETRY LIMIT | MIU 137 | HEX | | |
| | 56-61 | 0-47 | CCSDS TIMETAG SCI PKT 1 | MIU 128. 129, 130 | HEX | (LSB=2^-16) | MHS |
| | 62-97 | | FIRST 18 WORDS OF SCI PKT 1 | | | | |
| 55-79 | 48-97 | | NEXT 25 WORDS OF SCI PKT 1 | | | | |

* Packet 2 (PKT 2) reports the prior 8-second period (n-1).

### 4.2.6. AIP Bytes 48-97 Fast Dump Mode

AIP Fast Dump Mode is described in the Table below. Bytes 48-97 are used for the dump. Bytes 48-51 are the dump address and 52-97 are the next 23 words of the dump. This process will repeat and continue until all the requested data words have been dumped.

**TABLE 4.2.6-1 - AIP Bytes 48-97 Fast Dump Mode**

| *MINOR CYCLE* | *BYTE* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|---|
| ALL | 48-51 | 0-31 | CURRENT RAM DUMP ADDRESS | MIU 462<br>MIU 463 | HEX<br>HEX | MSW OF ADRS<br>LSW OF ADRS | MEMORY DUMP |
| | 52-97 | | NEXT 23 WORDS OF RAM DUMP | | | | |

### 4.2.7. AIP Bytes 48-97 Bus Engineering Mode

Bus Engineering Mode outputs in five formats or transaction types: NIL, MISC (Miscellaneous), HK (Housekeeping), SCI (Science), and CMD (Command.). Each cycle described below has its respective table illustrating its format and information

The NIL cycle is described as a placeholder (No Op) mode. NIL is the transaction type that is performed per the Bus Utilization Table (BUT) when no other transaction is requested and its purpose is to kill time, until its time to perform another operation. The NIL Cycle outputs 1553B Bus data including HK, SCI, CMD, MISC and other error, valid, and re-try counts. Current Transaction type (NIL, MISC, HK, SCI, CMD) and Machine State (Idle, State0, etc.) are sent in bytes 98-101 in all modes. Machine States are described in the MIU Firmware Design Document sections 4.10.6.1.4 through 4.10.6.1.7. Refer to Table 4.2.7-1 for further details.

MISC Cycle outputs test results from WRAP and BIT for the HK and SCI RT channels. First, various failed and reset counters are output. Next HK WRAP results are sent in bytes 66-75 and SCI WRAP test results sent in bytes 76-85. In bytes 86-91 are sent the HK BIT Test Results followed by the SCI BIT Test results in bytes 92-97. Refer to Table 4.2.7-2 for further details.

Housekeeping Cycle sends failed and re-try counters on HK issues from bytes 48-73. Next, the previous scan Period Collection results are sent from bytes 74-85. In bytes 86-97 is sent the last HK 1553B Error Table entry. Refer to Table 4.2.7-3 for further details.

Science (SCI) Cycle sends various failed and re-try counters on SCI issues from bytes 48-73. Bytes 74-85 hold the previous scan Period Collection results. The last SCI 1553B Error Table Entry is sent in bytes 86-97. Refer to Table 4.2.7-4 for further details.

Command (CMD) Cycle sends various failed and re-try counters on CMD issues from bytes 48-73. Bytes 74-85 include the last Misc. 1553B Error Table Entry including major and minor cycle count and numerous other 1553B bus data. The last Command 1553B Error Table Entry is sent in bytes 86-97. Refer to Table 4.2.7-5 for further details.

**TABLE 4.2.7-1 - MIU AIP TLM Bytes 48-97 Bus Engineering Mode (N1L)**

| *Trnsact Type* | *BYTE* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|---|
| NIL | 48-49 | 0-15 | HK Failed Collection Count | MIU 150 | HEX | | 1553 Bus BCRT |
| | 50-51 | 0-15 | HK TLM Request Retries Count | MIU 151 | HEX | | |
| | 52-53 | 0-15 | HK TVW Retries Count | MIU 152 | HEX | | |
| | 54-55 | 0-15 | HK TLM Collection Retries Count | MIU 153 | HEX | | |
| | 56-57 | 0-15 | HK CCSDS Valid Packets Count | MIU 154 | HEX | | |
| | 58-59 | 0-15 | HK 1553B Error Table Index | MIU 155 | HEX | | |
| | 60-61 | 0-15 | Sci Failed Collection Count | MIU 156 | HEX | | |
| | 62-63 | 0-15 | Sci TLM Request Retries Count | MIU 157 | HEX | | |
| | 64-65 | 0-15 | Sci TVW Retries Count | MIU 158 | HEX | | |
| | 66-67 | 0-15 | Sci TLM Collection Retries Count | MIU 159 | HEX | | |
| | 68-69 | 0-15 | Sci CCSDS Valid Packets Count | MIU 160 | HEX | | |
| | 70-71 | 0-15 | Sci 1553B Error Table Index | MIU 161 | HEX | | |
| | 72-73 | 0-15 | Skipped MHS Commands Count | MIU 162 | HEX | | |
| | 74-75 | 0-15 | Successful MHS Commands Count | MIU 163 | HEX | | |
| | 76-77 | 0-15 | Cmd Machine Reset Count | MIU 164 | HEX | | |
| | 78-79 | 0-15 | Cmd Machine Retries Count | MIU 165 | HEX | | |
| | 80-81 | 0-15 | Cmd 1553B Error Table Index | MIU 166 | HEX | | |
| | 82-83 | 0-15 | Pending MHS Cmd Count | MIU 167 | HEX | | |
| | 84-85 | 0-15 | Misc Trans Failed Count | MIU 168 | HEX | | |
| | 86-87 | 0-15 | Misc Trans Success Count | MIU 169 | HEX | | |
| | 88-89 | 0-15 | Misc Machine Reset Count | MIU 170 | HEX | | |
| | 90-91 | 0-15 | Misc Machine Retries Count | MIU 171 | HEX | | |
| | 92-93 | 0-15 | Misc Mach 1553B Error Table Index | MIU 172 | HEX | | |
| | 94 | 0-7 | Wrap Test Failed Count | MIU 173 | HEX | 8 BITS | |
| | 95 | 0-7 | Bit Failed Count | MIU 174 | HEX | 8 BITS | |
| | 96-97 | 0-15 | Exception Occurred Count | MIU 175 | HEX | | |

## TABLE 4.2.7-2 – MIU AIP BUS ENGR MODE (MISC)

| *Trnsact Type* | *BYTE* | *BITS* | *DESCRIPTION* | *TLM* | *STATI* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|---|
| MISC | 48-49 | 0-15 | MISC TRNS FAIL COUNT | MIU 176 | HEX | | 1553 Bus BCRT |
| | 50-51 | 0-15 | MISC TRNS SUCCESS COUNT | MIU 177 | HEX | | |
| | 52-53 | 0-15 | MISC MACHINE RESET COUNT | MIU 178 | HEX | | |
| | 54-55 | 0-15 | MISC Machine Retries Count | MIU 179 | HEX | | |
| | 56-57 | 0-15 | MISC Mach 1553b Error Table Index | MIU 180 | HEX | | |
| | 58 | 0-7 | WRAP TEST FAILED COUNT | MIU 181 | HEX | 8 BITS | |
| | 59 | 0-7 | BIT FAILED COUNT | MIU 182 | HEX | 8 BITS | |
| | 60-61 | 0-15 | WRAP TEST Pattn Mod Enabled | MIU 183 | HEX | | |
| | 62-63 | 0-14 | RESERVED | | | | |
| | | 15 | BUS OVERRUN OCCURRED | MIU 184 | 0/1 | 0=no; 1=yes | |
| | 64-65 | 0-15 | Last CMD During Bus Overrun | MIU 185 | HEX | | |
| | 66-75 | ===> | Prev Scan HK Wrap Test Results | <===== | === | ================ | |
| | 66-67 | 0-15 | REQUEST STATUS WORD | MIU 186 | HEX | | |
| | 68-69 | 0-15 | COLLECTION STATUS WORD | MIU 187 | HEX | | |
| | 70-71 | 0-15 | INDEX OF BAD MATCH | MIU 188 | HEX | | |
| | 72-73 | 0-15 | EXPECTED DATA | MIU 189 | HEX | | |
| | 74-75 | 0-15 | RECEIVED DATA | MIU 190 | HEX | | |
| | 76-85 | ===> | Prev Scan Sci Wrap Test Results | <===== | === | ================ | |
| | 76-77 | 0-15 | REQUEST STATUS WORD | MIU 191 | HEX | | |
| | 78-79 | 0-15 | Collection Status Word | MIU 192 | HEX | | |
| | 80-81 | 0-15 | INDEX OF BAD MATCH | MIU 193 | HEX | | |
| | 82-83 | 0-15 | EXPECTED DATA | MIU 194 | HEX | | |
| | 84-85 | 0-15 | RECEIVED DATA | MIU 195 | HEX | | |
| | 86-91 | ===> | Prev Scan HK Bit Test Results | <===== | === | ================ | |
| | 86-87 | 0-15 | REQUEST STATUS WORD | MIU 196 | HEX | | |
| | 88-89 | 0-15 | Collection Status Word | MIU 197 | HEX | | |
| | 90-91 | 0-15 | RECEIVED BIT WORD | MIU 198 | HEX | | |
| | 92-97 | ===> | Prev Scan Sci BIT Test Results | <===== | === | ================ | |
| | 92-93 | 0-15 | REQUEST STATUS WORD | MIU 199 | HEX | | |
| | 94-95 | 0-15 | Collection Status Word | MIU 200 | HEX | | |
| | 96-97 | 0-15 | RECEIVED BIT WORD | MIU 201 | HEX | | |

# TABLE 4.2.7-3 - MIU AIP BUS ENGR MODE (HK)

| Trnsact Type | BYTE | BITS | DESCRIPTION | TLM | STATI | DEFINITION | MIU SUBSYSTEM |
|---|---|---|---|---|---|---|---|
| HK | 48-49 | 0-15 | HK Failed Collection Count | MIU 202 | HEX | | 1553 Bus BCRT |
| | 50-51 | 0-15 | HK Successful Collection Count | MIU 203 | HEX | | |
| | 52-53 | 0-15 | HK Machine Resets Count | MIU 204 | HEX | | |
| | 54-55 | 0-15 | HK TLM Request Retries Count | MIU 205 | HEX | | |
| | 56-57 | 0-15 | HK TVW Retries Count | MIU 206 | HEX | | |
| | 58-59 | 0-15 | HK TLM Collection Retries Count | MIU 207 | HEX | | |
| | 60-61 | 0-15 | HK CCSDS Pkt Id Failed Count | MIU 208 | HEX | | |
| | 62-63 | 0-15 | HK CCSDS Pkt Length Failed Count | MIU 209 | HEX | | |
| | 64-65 | 0-15 | HK CCSDS Pkt Chksm Failed Count | MIU 210 | HEX | | |
| | 66-67 | 0-15 | HK CCSDS Pkt Valid Pkts Count | MIU 211 | HEX | | |
| | 68-69 | 0-15 | HK 1553b Error Table Index | MIU 212 | HEX | | |
| | 70-71 | 0-14 | Reserved | | HEX | | |
| | | 15 | Bus Overrun Occurred | MIU 213 | 0/1 | 0=no, 1= Yes | |
| | 72-73 | 0-15 | Last Command During Bus Overrun | MIU 214 | HEX | | |
| | 74-85 | ====> | Prev Scan Period Collection Results | <===== | ==== | =============== | |
| | 74-75 | 0-13 | Reserved | | | | |
| | | 14-15 | Scan Period | MIU 215 | HEX | | |
| | 76-79 | 0-31 | Major Cycle Count | MIU 216<br>MIU 217 | HEX<br>HEX | MSW<br>LSW | |
| | 80-81 | 0-15 | Minor Cycle Count | MIU 218 | HEX | | |
| | 82-83 | 0-14 | Reserved | | | | |
| | | 15 | HK Machine Mode | MIU 219 | 0/1 | 0 =TLM, 1 =Dump | |
| | 84-85 | 0-14 | Reserved | | | | |
| | | 15 | Collection Successful | MIU 220 | 0/1 | 1= no, 0= Yes | |
| | 86-97 | | Last HK 1553b Error Table Entry | | | | |
| | 86-89 | 0-31 | Major Cycle Count | MIU 221<br>MIU 222 | HEX<br>HEX | MSW<br>LSW | |
| | 90-91 | 0-15 | Minor Cycle Count | MIU 223 | HEX | | |
| | 92-93 | 0-15 | Command Block Address | MIU 224 | HEX | | |
| | 94-95 | 0 | Reserved | | | | |
| | | 1 | Status Word Error | MIU 225 | 0/1 | 0=no, 1= Yes | |
| | | 2 | RT Address Error | MIU 226 | 0/1 | 0=no, 1= Yes | |
| | | 3 | Control Word Message Error | MIU 227 | 0/1 | 0=no, 1= Yes | |
| | | 4-15 | Reserved | | | | |
| | 96-97 | 0-4 | RT Address | MIU 228 | HEX | | |
| | | 5 | SW Message Error | MIU 229 | 0/1 | 0=no, 1= Yes | |
| | | 6 | Instrumentation | MIU 230 | 0/1 | 0=no, 1= Yes | |
| | | 7 | Service Request | MIU 231 | 0/1 | 0=no, 1= Yes | |
| | | 8 | Control Word Message Error | MIU 232 | 0/1 | 0=no, 1= Yes | |
| | | 9-10 | Reserved | | | | |
| | | 11 | Broadcast Command Received | MIU 233 | 0/1 | 0=no, 1= Yes | |
| | | 12 | Busy | MIU 234 | 0/1 | 0=no, 1= Yes | |
| | | 13 | Subsystem Flag | MIU 235 | 0/1 | 0=no, 1= Yes | |
| | | 14 | Dynamic Bus Acceptance | MIU 236 | 0/1 | 0=no, 1= Yes | |
| | | 15 | Terminal Flag | MIU 237 | 0/1 | 0=no, 1= Yes | |

# TABLE 4.2.7-4 - MIU AIP BUS ENGR MODE (SCI)

| *Trnsact Type* | *BYTE* | *BITS* | *DESCRIPTION* | *TLM* | *STATI* | *DEFINITION* | *MIU SUBSYSTE* |
|---|---|---|---|---|---|---|---|
| SCI | 48-49 | 0-15 | Sci Failed Collection Count | MIU 240 | HEX | | 1553 Bu<br>BCRT |
| | 50-51 | 0-15 | Sci Successful Collection Count | MIU 241 | HEX | | |
| | 52-53 | 0-15 | Sci Machine Resets Count | MIU 242 | HEX | | |
| | 54-55 | 0-15 | Sci TLM Request Retries Count | MIU 243 | HEX | | |
| | 56-57 | 0-15 | Sci TVW Retries Count | MIU 244 | HEX | | |
| | 58-59 | 0-15 | Sci TLM Collection Retries Count | MIU 245 | HEX | | |
| | 60-61 | 0-15 | Sci CCSDS Packet Id Failed Count | MIU 246 | HEX | | |
| | 62-63 | 0-15 | Sci CCSDS Packet Length Failed | MIU 247 | HEX | | |
| | 64-65 | 0-15 | Sci CCSDS Packet Checksum Failed | MIU 248 | HEX | | |
| | 66-67 | 0-15 | Sci CCSDS Packet Valid Packets | MIU 249 | HEX | | |
| | 68-69 | 0-15 | Sci 1553B Error Table Index | MIU 250 | HEX | | |
| | 70-71 | 0-14 | Reserved | | HEX | | |
| | | 15 | Bus Overrun Occurred | MIU 251 | 0/1 | 0=no, 1= Yes | |
| | 72-73 | 0-15 | Last Command During Bus Overrun | MIU 252 | HEX | | |
| | 74-85 | ====> | Prev Scan Period Collection Results | <===== | ==== | ================ | |
| | 74-75 | 0-13 | Reserved | | | | |
| | | 14-15 | Scan Period | MIU 253 | HEX | | |
| | 76-79 | 0-31 | Major Cycle Count | MIU 254<br>MIU 255 | HEX<br>HEX | MSW<br>LSW | |
| | 80-81 | 0-15 | Minor Cycle Count | MIU 256 | HEX | | |
| | 82-83 | 0-14 | Reserved | | | | |
| | | 15 | Sci Machine Mode | MIU 257 | 0/1 | 0 =TLM, 1 =Dump | |
| | 84-85 | 0-14 | Reserved | | | | |
| | | 15 | Collection Successful | MIU 258 | 0/1 | 1= no, 0= Yes | |
| | 86-97 | | Last Sci 1553B Error Table Entry | | | | |
| | 86-89 | 0-31 | Major Cycle Count | MIU 259<br>MIU 260 | HEX<br>HEX | MSW<br>LSW | |
| | 90-91 | 0-15 | Minor Cycle Count | MIU 261 | HEX | | |
| | 92-93 | 0-15 | Command Block Address | MIU 262 | HEX | | |
| | 94-95 | 0 | Reserved | | | | |
| | | 1 | Status Word Error | MIU 263 | 0/1 | 0=no, 1= Yes | |
| | | 2 | RT Address Error | MIU 264 | 0/1 | 0=no, 1= Yes | |
| | | 3 | Control Word Message Error | MIU 265 | 0/1 | 0=no, 1= Yes | |
| | | 4-15 | Reserved | | | | |
| | 96-97 | 0-4 | RT Address | MIU 266 | HEX | | |
| | | 5 | SW Message Error | MIU 267 | 0/1 | 0=no, 1= Yes | |
| | | 6 | Instrumentation | MIU 268 | 0/1 | 0=no, 1= Yes | |
| | | 7 | Service Request | MIU 269 | 0/1 | 0=no, 1= Yes | |
| | | 8 | Control Word Message Error | MIU 270 | 0/1 | 0=no, 1= Yes | |
| | | 9-10 | Reserved | | | | |
| | | 11 | Broadcast Command Received | MIU 271 | 0/1 | 0=no, 1= Yes | |
| | | 12 | Busy | MIU 272 | 0/1 | 0=no, 1= Yes | |
| | | 13 | Subsystem Flag | MIU 273 | 0/1 | 0=no, 1= Yes | |
| | | 14 | Dynamic Bus Acceptance | MIU 274 | 0/1 | 0=no, 1= Yes | |
| | | 15 | Terminal Flag | MIU 275 | 0/1 | 0=no, 1= Yes | |

## TABLE 4.2.7-5 - MIU AIP BUS ENGR MODE (CMD)

| *Trnsact Type* | *BYTE* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|---|
| CMD | 48-49 | 0-15 | Skipped MHS Commands Count | MIU 276 | HEX | | 1553 Bus BCRT |
| | 50-51 | 0-15 | Successful MHS Commands Count | MIU 277 | HEX | | |
| | 52-53 | 0-15 | Cmd Machine Reset Count | MIU 278 | HEX | | |
| | 54-55 | 0-15 | Cmd Machine Retries Count | MIU 279 | HEX | | |
| | 56-57 | 0-15 | Cmd 1553B Error Table Index | MIU 280 | HEX | | |
| | 58-59 | 0-15 | Pending MHS Cmd Count | MIU 281 | HEX | | |
| | 60-61 | 0-15 | Bit Timeouts Count | MIU 282 | HEX | | |
| | 62-63 | 0-15 | Bit Results | MIU 283 | HEX | | |
| | 64-65 | 0-15 | Bus Reset Timeouts Count | MIU 284 | HEX | | |
| | 66-67 | 0-14 | Reserved | | | | |
| | | 15 | Bus Overrun Occurred | MIU 285 | 0/1 | 0 = no, 1 = Yes | |
| | 68-69 | 0-15 | Last Command During Bus Overrun | MIU 286 | HEX | | |
| | 70-71 | 0-12 | Reserved | | | | |
| | | 13 | Last Bus Used | MIU 287 | 0/1 | 1 = A Bus, 0 = B Bu: | |
| | | 14 | Ground Preferred Bus | MIU 288 | 0/1 | 1 = A Bus, 0 = B Bus | |
| | | 15 | MIU Preferred Bus | MIU 289 | 0/1 | 1 = A Bus, 0 = B Bu: | |
| | 72-73 | 0-15 | BCRTM Last Intr Log List Pointer | MIU 290 | HEX | | |
| | 75-85 | ====> | Last Misc 1553B Error Table Entry | <===== | ==== | =============== | |
| | 74-77 | 0-31 | Major Cycle Count | MIU 291<br>MIU 292 | HEX<br>HEX | MSW<br>LSW | |
| | 78-79 | 0-15 | Minor Cycle Count | MIU 293 | HEX | | |
| | 80-81 | 0-15 | Command Block Address | MIU 294 | HEX | | |
| | 82-83 | 0 | Reserved | | | | |
| | | 1 | Status Word Error | MIU 295 | 0/1 | 0 = no, 1 = Yes | |
| | | 2 | RT Address Error | MIU 296 | 0/1 | 0 = no, 1 = Yes | |
| | | 3 | Control Word Message Error | MIU 297 | 0/1 | 0 = no, 1 = Yes | |
| | | 4-15 | Reserved | | | | |
| | 84-85 | 0-4 | RT Address | MIU 298 | HEX | | |
| | | 5 | SW Message Error | MIU 299 | 0/1 | 0 = no, 1 = Yes | |
| | | 6 | Instrumentation | MIU 300 | 0/1 | 0 = no, 1 = Yes | |
| | | 7 | Service Request | MIU 301 | 0/1 | 0 = no, 1 = Yes | |
| | | 8 | Control Word Message Error | MIU 302 | 0/1 | 0 = no, 1 = Yes | |
| | | 9-10 | Reserved | | | | |
| | | 11 | Broadcast Command Received | MIU 303 | 0/1 | 0 = no, 1 = Yes | |
| | | 12 | Busy | MIU 304 | 0/1 | 0 = no, 1 = Yes | |
| | | 13 | Subsystem Flag | MIU 305 | 0/1 | 0 = no, 1 = Yes | |
| | | 14 | Dynamic Bus Acceptance | MIU 306 | 0/1 | 0 = no, 1 = Yes | |
| | | 15 | Terminal Flag | MIU 307 | 0/1 | 0 = no, 1 = Yes | |
| | 86-97 | ====> | Last Cmd 1553B Error Table Entry | <===== | ==== | =============== | |
| | 86-89 | 0-31 | Major Cycle Count | MIU 308<br>MIU 309 | HEX<br>HEX | MSW<br>LSW | |
| | 90-91 | 0-15 | Minor Cycle Count | MIU 310 | HEX | | |
| | 92-93 | 0-15 | Command Block Address | MIU 311 | HEX | | |

## TABLE 4.2.7-5 - MIU AIP BUS ENGR MODE (CMD) Cont.

| *Trnsact Type* | *BYTE* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYSTEM* |
|---|---|---|---|---|---|---|---|
| CMD | 94-95 | 0 | Reserved | | | | |
| | | 1 | Status Word Error | MIU 312 | 0/1 | 0 = no, 1 = Yes | |
| | | 2 | RT Address Error | MIU 313 | 0/1 | 0 = no, 1 = Yes | |
| | | 3 | Control Word Message Error | MIU 314 | 0/1 | 0 = no, 1 = Yes | |
| | | 4-15 | Reserved | | | | |
| | 96-97 | 0-4 | RT Address | MIU 315 | HEX | | 1553 Bus BCRT |
| | | 5 | SW Message Error | MIU 316 | 0/1 | 0 = no, 1 = Yes | |
| | | 6 | Instrumentation | MIU 317 | 0/1 | 0 = no, 1 = Yes | |
| | | 7 | Service Request | MIU 318 | 0/1 | 0 = no, 1 = Yes | |
| | | 8 | Control Word Message Error | MIU 319 | 0/1 | 0 = no, 1 = Yes | |
| | | 9-10 | Reserved | | | | |
| | | 11 | Broadcast Command Received | MIU 320 | 0/1 | 0 = no, 1 = Yes | |
| | | 12 | Busy | MIU 321 | 0/1 | 0 = no, 1 = Yes | |
| | | 13 | Subsystem Flag | MIU 322 | 0/1 | 0 = no, 1 = Yes | |
| | | 14 | Dynamic Bus Acceptance | MIU 323 | 0/1 | 0 = no, 1 = Yes | |
| | | 15 | Terminal Flag | MIU 324 | 0/1 | 0 = no, 1 = Yes | |

### 4.2.8. AIP Bytes 98-101 Normal Telemetry Mode

The following Table depicts the data sent in bytes 98-101 during AIP Normal Telemetry mode. This data repeats 4 times per major frame beginning with major and minor cycle counts in minor frames 0, 20,40, and 60. Telemetry data I/O Reads are sent in bytes 98-99 during minor frames 2, 22, 42, and 62. Some of the key TLM data from these AIP Bytes 98-101 includes TIP and AIP FIFO status, Bus Controller state, CIU State, Uplink queue, Cmd Verif word, Error Counts, Memory dump stats, Time and Error Log Indices.

## TABLE 4.2.8-1 - MIU AIP Telemetry Bytes 98-101 - Normal Telemetry Mode

| *MINOR CYCLE* | | | | *BYTE* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* | *MIU SUBSYS* |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 20 | 40 | 60 | 98-101 | 0-31 | Major Cycle Count | MIU 400<br>MIU 401 | HEX<br>HEX | MSW<br>LSW | TIME |
| 1 | 21 | 41 | 61 | 98-99 | 0-15 | Minor Cycle Error Count | MIU 402 | HEX | | |
| | | | | 100-101 | 0-14 | RESERVED | | | | |
| | | | | | 15 | MIU In Sync With Major Cycle | MIU 403 | 0/1 | 1 = YES , 0 = NO | |
| 2 | 22 | 42 | 62 | 98-99 | 0-15 | RESULTS OF I/O READ | MIU 404 | | | TLM |
| | | | | 100 | 0 | TIP FIFO WAS RESET | MIU 405 | 0/1 | 1 = YES , 0 = NO | ISR |
| | | | | | 1 | TIP FIFO WAS FULL | MIU 406 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 2 | TIP FIFO WAS EMPTY | MIU 407 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 3 | AIP FIFO WAS RESET | MIU 408 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 4 | AIP FIFO WAS FULL | MIU 409 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 5 | AIP FIFO WAS EMPTY | MIU 410 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 6 | Minor Cycle Sync Received | MIU 411 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 7 | Major Cycle Sync Received | MIU 412 | 0/1 | 1 = YES , 0 = NO | |

## TABLE 4.2.8-1 - MIU AIP Telemetry Bytes 98-101 - Normal Telemetry Mode (Cont.)

| MINOR CYCLE | | | | BYTE | BITS | DESCRIPTION | TLM | STATE | DEFINITION | MIU SUBSYS |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 22 | 42 | 62 | 101 | 0 | FIFO Reset Under S/W Control | MIU 413 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 1 | RESET AIP FIFO Commanded | MIU 414 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 2 | RESET TIP FIFO Commanded | MIU 415 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 3 | TIP FIFO DATA INVERTED | MIU 416 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 4 | AIP FIFO DATA INVERTED | MIU 417 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 5 | TIP FIFO ENABLED | MIU 418 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 6 | AIP FIFO ENABLED | MIU 419 | 0/1 | 1 = YES , 0 = NO | |
| | | | | | 7 | INT Reset Under S/W Control | MIU 420 | 0/1 | 1 = YES , 0 = NO | |
| 3 | 23 | 43 | 63 | 98-99 | 0-13 | RESERVED | | | | BUS CONTROL |
| | | | | | 14- | BUS CONTROLLER STATE | MIU 421 | 00<br>01<br>10<br>11 | OFF<br>ENABLING<br>ON<br>DISABLING | |
| | | | | 100-101 | 0-13 | RESERVED | | | | |
| | | | | | 14- | BUS CONTROLLER MODE | MIU 422 | 00<br>01<br>10<br>11 | TLM<br>HK DUMP<br>SCI DUMP<br>UNDEFINED | |
| | | | | | | | | | | |
| 4 | 24 | 44 | 64 | 98-99 | 0-14 | RESERVED | | | | BUS CONTROL |
| | | | | | 15 | Housekeeping Bus Process | MIU 423 | 0/1 | 0 =TLM, 1 =Dump | |
| | | | | 100-101 | 0-14 | RESERVED | | | | |
| | | | | | 15 | Science Bus Processing Mode | MIU 424 | 0/1 | 0 =TLM, 1 =Dump | |
| 5 | 25 | 45 | 65 | 98-99 | 0-15 | BC Unexplained Exceptions Cnt | MIU 425 | HEX | | |
| | | | | 100-101 | 0-15 | MHS CMD Queue Count | MIU 426 | HEX | | |
| 6 | 26 | 46 | 66 | 98 | 0-1 | CIU ISR STATE | MIU 427 | 00<br>01<br>10<br>11 | Waiting for next Cmd<br>Collecting Cmd hdr<br>Collecting Cmd hdr<br>Collecting datawords | UPLINK |
| | | | | | 2 | Uplink Queue Is Full | MIU 428 | 0/1 | 0 = no, 1 = Yes | |
| | | | | | 3 | Uplink Queue Was Reset | MIU 429 | 0/1 | 0 = no, 1 = Yes | |
| | | | | | 4-7 | RESERVED | | | | |
| | | | | 99 | 0-7 | Number Of Data Words Xfrd | MIU 430 | HEX | 8 BITS | |
| | | | | 100-101 | 0-15 | Cmd Verification Word | MIU 431 | HEX | | |
| 7 | 27 | 47 | 67 | 98-99 | 0-15 | Exception Occurred Count | MIU 432 | HEX | | ERROR |
| | | | | 100-101 | 0-15 | Unhandled Interrupt Count | MIU 433 | HEX | | |
| 8 | 28 | 48 | 68 | 98-99 | 0-14 | RESERVED | | | | |
| | | | | | 15 | Memory Scrub Enabled | MIU 434 | 0/1 | 0 = no, 1 = Yes | |
| | | | | 100-101 | 0-15 | Single Bit Error Count | MIU 435 | HEX | | |

## TABLE 4.2.8-1 - MIU AIP Telemetry Bytes 98-101 - Normal Telemetry Mode (Cont.)

| MINOR CYCLE | | | | BYTE | BITS | DESCRIPTION | TLM | STATI | DEFINITION | MIU SUBSYS |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 29 | 49 | 69 | 98-101 | 0-31 | Last Ram Address Scrubbed | MIU 436<br>MIU 437 | HEX<br>HEX | MSW<br>LSW | |
| 10 | 30 | 50 | 70 | 98-99 | 0-15 | Machine Error Count | MIU 438 | HEX | | MEM |
| | | | | 100-101 | 0-14 | RESERVED | | | | UTIL |
| | | | | | 15 | Stuck Bit Detected | MIU 439 | 0/1 | 0 = YES, 1 = NO | |
| 11 | 31 | 51 | 71 | | 0-31 | Address Of Stuck Bit | MIU 440<br>MIU 441 | HEX<br>HEX | MSW<br>LSW | |
| 12 | 32 | 52 | 72 | 98-99 | 0-14 | RESERVED | | | | |
| | | | | | 15 | Memory Checksum Enabled | MIU 442 | 0/1 | 0 = YES, 1 = NO | |
| | | | | 100-101 | 0-15 | Memory Checksum Error Count | MIU 443 | HEX | | |
| 13 | 33 | 53 | 73 | 98-101 | 0-31 | Ram Dump Start Address | MIU 444<br>MIU 445 | HEX<br>HEX | MSW<br>LSW | |
| 14 | 34 | 54 | 74 | 98-101 | 0-31 | HK Bus Memory Dump Start Address | MIU 446<br>MIU 447 | HEX<br>HEX | MSW<br>LSW | BUS |
| 15 | 35 | 55 | 75 | 98-101 | 0-31 | Sci Bus Memory Dump Start Address | MIU 448<br>MIU 449 | HEX<br>HEX | MSW<br>LSW | |
| 16 | 36 | 56 | 76 | 98-101 | 0-31 | Ram Dump Requested Word Count | MIU 450<br>MIU 451 | HEX<br>HEX | MSW<br>LSW | MEM |
| 17 | 37 | 57 | 77 | 98-99 | 0-15 | HK Dump Requested Word Count | MIU 452 | HEX | | BUS |
| | | | | 100-101 | 0-15 | Sci Dump Requested Word Count | MIU 453 | HEX | | |
| 18 | 38 | 58 | 78 | 98-99 | 0-15 | Main Cycle Count | MIU 454 | HEX | | MAIN |
| | | | | 100-101 | 0-15 | Minor Frame Reception Tolerance | MIU 455 | HEX | | TIME |
| 19 | 39 | 59 | 79 | 98-99 | 0-15 | Exception Log Save Index | MIU 456 | HEX | | ERROR |
| | | | | 100-101 | 0-15 | Interrupt Log Save Index | MIU 457 | HEX | | |

### 4.2.9. AIP Bytes 98-101 Bus Engineering Mode

The Bus Engineering Mode sends TLM data via bytes 98-101 providing information on Transaction Types: NIL, MISC, HK, SCI, and SCI Telemetry. This mode also provides visibility to internal telemetry Machine States for each of these transaction types. Machine States are described in the MIU Firmware Design Document reference sections 4.10.6.1.4 through 4.10.6.1.7. The following table describes the AIP Bus Engineering Mode TLM.

**TABLE 4.2.9-1 - MIU AIP Telemetry Bytes 98-101 - Bus Engineering Mode**

| *MINOR CYCLE* | *BYTE* | *TRANS TYPE* | *BITS* | *DESCRIPTION* | *TLM* | *STATE* | *DEFINITION* |
|---|---|---|---|---|---|---|---|
| ALL | 98-99 | ALL | 0-12 | RESERVED | | | |
| | | | 13-15 | CURRENT TRANS TYPE | MIU 458 | 000 | NIL |
| | | | | | | 001 | Misc |
| | | | | | | 010 | HK Telemetry |
| | | | | | | 011 | Sci Telemetry |
| | | | | | | 100 | Command |
| | | | | | | 101 | Undefined |
| | | | | | | 110 | Undefined |
| | | | | | | 111 | Undefined |
| | 100-101 | | | MACH STATE FOR CURR TRANS | | | |
| | | NIL | 0-13 | RESERVED | | | |
| | | | 14-15 | BUS CONTROLLER STATE | MIU 421 | 00 | OFF |
| | | | | | | 01 | ENABLING |
| | | | | | | 10 | ON |
| | | | | | | 11 | DISABLING |
| | | MISC | 0-13 | RESERVED | | | |
| | | | 14-15 | MISC MACHINE STATE | MIU 459 | 00 | Idle |
| | | | | | | 01 | State 0 |
| | | | | | | 10 | State 1 |
| | | | | | | 11 | Undefined |
| | | HK | 0-12 | RESERVED | | | |
| | | | 13-15 | HK MACHINE STATE | MIU 460 | 000 | Idle |
| | | | | | | 001 | TLM State 0 |
| | | | | | | 010 | TLM State 1 |
| | | | | | | 011 | TLM State 2 |
| | | | | | | 100 | Dump State 0 |
| | | | | | | 101 | Dump State 1 |
| | | | | | | 110 | Dump State 2 |
| | | | | | | 111 | Undefined |
| | | SCI | 0-12 | RESERVED | | | |
| | | | 13-15 | SCI MACHINE STATE | MIU 466 | 000 | Idle |
| | | | | | | 001 | TLM State 0 |
| | | | | | | 010 | TLM State 1 |
| | | | | | | 011 | TLM State 2 |
| | | | | | | 100 | Dump State 0 |
| | | | | | | 101 | Dump State 1 |
| | | | | | | 110 | Dump State 2 |
| | | | | | | 111 | Undefined |
| | | CMD | 0-14 | RESERVED | | | |
| | | | 15 | MISC MACHINE STATE | MIU 461 | 0 | Idle |
| | | | | | | 1 | State 0 |

## 4.2.10. AIP Bytes 98-101 Slow Dump Mode

Slow Dump Mode provides all dump data in minor cycles 1-79, while minor cycle 0 sends the current Dump Address. This mode of operation was described in section 3.9.2.3 of this document. The following table details the Slow Dump TLM.

**TABLE 4.2.10-1 - AIP Bytes 98-101 Slow Dump Mode**

| MINOR CYCLE | BYTE | BITS | DESCRIPTION | TLM | STATE | DEFINITION | SUBSYS |
|---|---|---|---|---|---|---|---|
| 0 | 98-101 | 0-31 | CURRENT DUMP ADDRESS | MIU 462<br>MIU 463 | HEX<br>HEX | MSW<br>LSW | MEMORY |
| 1-79 | 98-99<br>100-101 | 0-15<br>0-15 | MEMORY DUMP DATA<br>MEMORY DUMP DATA | MIU 464<br>MIU 465 | HEX<br>HEX | | |

## 4.3. TABLE DUMP FORMATS Slow Dump Submode

Slow Dump Submode outputs specific table data (10 different tables, as depicted in the following 4.3.x paragraphs) from the MIU. See section 3.9.8 in this document for additional information.

### 4.3.1. Exception Log

Each Table Slot contains the Logical Address, CPU Status Word, Exception Type, Most Significant (MS) and Least Significant (LS) Major Cycle time, and Minor Cycle Time when the exception occurred. See Tables below for a definition of each Exception Log Table Entry.

## TABLE 4.3.1-1 - Slow Dump Submode (Exception Log Dump)

| *TABLE SLOT* | *MAJOR CYCLE* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* | | | |
|---|---|---|---|---|---|---|
| | | | ***98*** | ***99*** | ***100*** | ***101*** |
| N/A | n | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 1 | n | 1 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 2 | EXCEPTION TYPE | | MS MAJOR CYCLE TIME | |
| | | 3 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 2 | n | 4 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 5 | EXCEPTION TYPE | | MS MAJOR CYCLE TIME | |
| | | 6 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 3 - 27 | n | 7 - 79 | Repeats in same format as above (3 minor cycles/slot) Until Minor Cycle=79 while Major Cycle=n | | | |
| N/A | n+1 | 0 | **CURRENT DUMP ADDRESS** | | | |
| 27 | n+1 | 1 | EXCEPTION TYPE | | MS MAJOR CYCLE TIME | |
| | | 2 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 28 | n+1 | 3 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 4 | EXCEPTION TYPE | | MS MAJOR CYCLE TIME | |
| | | 5 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 29-50 | n+1 | 6 - 71 | Repeats in same format as above (3 minor cycles/slot) Until Minor Cycle=72 while Major Cycle=n+1 | | | |
| | | | | | | |
| | | | | | | |
| N/A | n+1 | 72- 79 | FILLER | | FILLER | |

## TABLE 4.3.1-2 - Slow Dump Submode – Exception Log Definition

| *MINOR CYCLE* | *'YTE* | *BITS* | *'ESCRIPTION* | *'TATE / DEFINITION* |
|---|---|---|---|---|
| 1 | 8-99 | 0-15 | LOGICAL ADDRESS WHERE EXCEPTION WAS RAISEI | |
| | 100-101 | 0 | CARRY FLAG | |
| | | 1 | GREATER THAN (ZERO) FLAG | |
| | | 2 | EQUAL TO (ZERO) FLAG | |
| | | 3 | LESS THAN (ZERO) FLAG | |
| | | 4-7 | RESERVED | |
| | | 8-11 | PROCESSOR STATE | NOT USED |
| | | 12-15 | ADDRESS STATE | NOT USED |
| 2 | 8-99 | 0-12 | RESERVED | |
| | | 13-15 | EXCEPTION TYPE | 000 – None<br>001 – Numeric<br>010 – Constraint<br>011 – Program<br>100 – Storage<br>101 – Tasking<br>110 – Forced Termination<br>111 – Runtime |
| | 100-101 | 0-15 | MS MAJOR CYCLE TIME | |
| 3 | 8-99 | 0-15 | LS MAJOR CYCLE TIME | |
| | 100-101 | 0-15 | MINOR CYCLE TIME | |
| **OTHERS** | | | **REPEAT MINOR CYCLES 1-3 (49 TIMES)** | |

### 4.3.2. Interrupt Log

Each Table Slot contains the Interrupt Number, CPU Status Word, Conditional Data, Most Significant (MS) and Least Significant (LS) Major Cycle time, and Minor Cycle Time when the interrupt occurred. See following Table for a definition of each Interrupt Log Table Entry.

**TABLE 4.3.2-1 – MIU SLOW DUMP SUBMODE – Interrupt Log Dump Format (Part 1 of 5)**

| *TABLE SLOT* | *MAJOR CYCLE* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* 98 | 99 | 100 | 101 |
|---|---|---|---|---|---|---|
| N/A | n | 0 | PHYSICAL TABLE ADDRESS | | | |
| 1 | n | 1 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 2 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 3 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 4 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 2 | n | 5 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 6 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 7 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 3 | n | 8 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 9 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 10 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 11 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 4 | n | 12 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 13 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 14 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 5 | n | 15 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 16 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 17 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 18 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 6 | n | 19 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 20 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 21 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 7 | n | 22 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 23 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 24 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 25 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 8 | n | 26 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 27 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 28 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 9 | n | 29 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 30 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 31 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 32 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 10 | n | 33 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 34 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 35 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 11 | n | 36 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 37 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 38 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 39 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |

**TABLE 4.3.2-1 – MIU SLOW DUMP SUBMODE – Interrupt Log Dump Format (Part 2 of 5)**

| *TABLE SLOT* | *1AJOR :YCLE* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* | | | |
|---|---|---|---|---|---|---|
| | | | *8* | *9* | *00* | *01* |
| 12 | n | 40 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 41 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 42 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 13 | n | 43 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 44 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 45 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 46 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 14 | n | 47 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 48 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 49 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 15 | n | 50 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 51 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 52 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 53 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 16 | n | 54 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 55 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 56 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 17 | n | 57 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 58 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 59 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 60 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 18 | n | 61 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 62 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 63 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 19 | n | 64 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 65 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 66 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 67 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 20 | n | 68 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 69 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 70 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 21 | n | 71 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 72 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 73 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 74 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 22 | n | 75 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 76 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 77 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 23 | n | 78 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 79 | CPU STATUS WORD | | CONDITIONAL DATA | |
| N/A | n+1 | 0 | **CURRENT DUMP ADDRESS** | | | |
| 23 | n+1 | 1 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 2 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |

## TABLE 4.3.2-1 – MIU SLOW DUMP SUBMODE – Interrupt Log Dump Format (Part 3 of 5)

| *TABLE SLOT* | *MAJOR CYCLE* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* | | | |
|---|---|---|---|---|---|---|
| | | | *8* | *9* | *00* | *01* |
| 24 | n + 1 | 3 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 4 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 5 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 25 | n + 1 | 6 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 7 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 8 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 9 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 26 | n + 1 | 10 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 11 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 12 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 27 | n + 1 | 13 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 14 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 15 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 16 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 28 | n + 1 | 17 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 18 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 19 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 29 | n + 1 | 20 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 21 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 22 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 23 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 30 | n + 1 | 24 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 25 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 26 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 31 | n + 1 | 27 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 28 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 29 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 30 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 32 | n + 1 | 31 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 32 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 33 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 33 | n + 1 | 34 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 35 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 36 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 37 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 34 | n + 1 | 38 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 39 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 40 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 35 | n + 1 | 41 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 42 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 43 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 44 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |

## TABLE 4.3.2-1 – MIU SLOW DUMP SUBMODE – Interrupt Log Dump Format (Part 4 of 5)

| *TABLE SLOT* | *IAJOR 'YCLE* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* | | | |
|---|---|---|---|---|---|---|
| | | | *8* | *9* | *00* | *01* |
| 36 | n + 1 | 45 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 46 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 47 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 37 | n + 1 | 48 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 49 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 50 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 51 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 38 | n + 1 | 52 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 53 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 54 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 39 | n + 1 | 55 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 56 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 57 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 58 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 40 | n + 1 | 59 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 60 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 61 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 41 | n + 1 | 62 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 63 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 64 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 65 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 42 | n + 1 | 66 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 67 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 68 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 43 | n + 1 | 69 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 70 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 71 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 72 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 44 | n + 1 | 73 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 74 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 75 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 45 | n + 1 | 76 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 77 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 78 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 79 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| N/A | n + 2 | 0 | **CURRENT DUMP ADDRESS** | | | |
| 46 | n + 2 | 1 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 2 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 3 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 47 | n + 2 | 4 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 5 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 6 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 7 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |

### TABLE 4.3.2-1 – MIU SLOW DUMP SUBMODE – Interrupt Log Dump Format (Part 5 of 5)

| *TABLE SLOT* | *4AJOR 'YCLE* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* | | | |
|---|---|---|---|---|---|---|
| | | | *8* | *9* | *00* | *01* |
| 48 | n + 2 | 8 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 9 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 10 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| 49 | n + 2 | 11 | INTERRUPT NUMBER | | LOGICAL ADDRESS | |
| | | 12 | CPU STATUS WORD | | CONDITIONAL DATA | |
| | | 13 | MS MAJOR CYCLE TIME | | LS MAJOR CYCLE TIME | |
| | | 14 | MINOR CYCLE TIME | | INTERRUPT NUMBER | |
| 50 | n + 2 | 15 | LOGICAL ADDRESS | | CPU STATUS WORD | |
| | | 16 | CONDITIONAL DATA | | MS MAJOR CYCLE TIME | |
| | | 17 | LS MAJOR CYCLE TIME | | MINOR CYCLE TIME | |
| *N/A* | *n + 2* | *18-79* | ***FILLER*** | | ***FILLER*** | |

### TABLE 4.3.2-2 - MIU Slow Dump Submode – Interrupt Log Definition

| *MINOR CYCLE* | *!YTE* | *BITS* | *DESCRIPTION* | *STATE / DEFINITION* |
|---|---|---|---|---|
| 1 | 8-99 | 0-11 | RESERVED | |
| | | 12-15 | INTERRUPT NUMBER | 0000 – POWER DOWN (0)<br>0001 – MACHINE ERROR (1)<br>0010 – SPARE (2)<br>0011 – FLOATING POINT OVERFLOW (3)<br>0100 – FIXED POINT OVERFLOW (4)<br>0101 – EXECUTIVE CALL (5)<br>0110 – FLOATING POINT UNDERFLOW (6)<br>0111 – TIMER A (7)<br>1000 – FIFO PRIORITY (8)<br>1001 – TIMER B (9)<br>1010 – 1553B PRIORITY (10)<br>1011 – FRAME SYNCS (11)<br>1100 – CIU COMMAND (12)<br>1101 – SPARE (13)<br>1110 – 1553B SINGLE EVENT FLAG (14)<br>1111 – CPU SINGLE EVENT FLAG (15) |
| | 100-101 | 0-15 | LOGICAL ADDRESS WHERE INTERRUPT OCCURRED | |
| 2 | 8-99 | 0 | CARRY FLAG | |
| | | 1 | GREATER THAN (ZERO) FLAG | |
| | | 2 | EQUAL TO (ZERO) FLAG | |
| | | 3 | LESS THAN (ZERO) FLAG | |
| | | 4-7 | RESERVED | |
| | | 8-11 | PROCESSOR STATE | NOT USED |
| | | 12-15 | ADDRESS STATE | NOT USED |

## TABLE 4.3.2-2 - MIU Slow Dump Submode – Interrupt Log Definition (Cont.)

| *MINOR CYCLE* | *BYTE* | *BITS* | *DESCRIPTION* | *STATE / DEFINITION* | | |
|---|---|---|---|---|---|---|
| 3 | 00-101 | 0-15 | CONDITIONAL DATA: | | | |
| | | | **MACHINE ERROR** | **1553B SEF** | **CPU SEF** | **OTHERS** |
| | | | CPU FAULT REG: | BCRTM ERR WORD: | CPU ERROR WORD: | |
| | | 0 | PAGE REG PARITY | HIGH PRI INT | LOG PAGE ADDR 0 | ZERO |
| | | 1 | NOT USED | LOW PRI INT | LOG PAGE ADDR 1 | |
| | | 2 | DOUBLE EVENT FLAG | SHD RAM ADDR A1 | LOG PAGE ADDR 2 | |
| | | 3 | NOT USED | SHD RAM ADDR A2 | LOG PAGE ADDR 3 | |
| | | 4 | NOT USED | SHD RAM ADDR A3 | PHYS ADDR 2 | |
| | | 5 | ILL I/O | SHD RAM ADDR A4 | PHYS ADDR 3 | |
| | | 6 | NOT USED | SHD RAM ADDR A5 | PHYS ADDR 4 | |
| | | 7 | ILLEGAL GROUP | SHD RAM ADDR A6 | INSTR/OPER | |
| | | 8 | ILLEGAL ADDRESS | BCRTM SEF | CPU SEF | |
| | | 9 | ILLEGAL INSTR | BCRTM DEF | CPU DEF | |
| | | 10 | PRIV INSTR FAULT | SYNDROME BIT 0* | SYNDROME BIT 0* | |
| | | 11 | ADDR STATE FAULT | SYNDROME BIT 1* | SYNDROME BIT 1* | |
| | | 12 | NOT USED | SYNDROME BIT 2* | SYNDROME BIT 2* | |
| | | 13 | BYTE* | SYNDROME BIT 3* | SYNDROME BIT 3* | |
| | | 14 | BYTE* | SYNDROME BIT 4* | SYNDROME BIT 4* | |
| | | 15 | BYTE* | SYNDROME BIT 5* | SYNDROME BIT 5* | |
| 4 | 8-99 | 0-15 | MS MAJOR CYCLE TIME | | | |
| | 100-101 | 0-15 | LS MAJOR CYCLE TIME | | | |
| 5 | 8-99 | 0-15 | MINOR CYCLE TIME | | | |
| | 100-101 | 0-11 | RESERVED | | | |
| | | 12-15 | INTERRUPT NUMBER | | | |
| 6 | 8-99 | 0-15 | LOGICAL ADDRESS WHERE INTERRUPT OCCURRED | | | |
| | 100-101 | 0-15 | CPU STATUS WORD | | | |
| 7 | 8-99 | 0-15 | CONDITIONAL DATA | | | |
| | 100-101 | 0-15 | MS MAJOR CYCLE TIME | | | |
| 8 | 8-99 | 0-15 | LS MAJOR CYCLE TIME | | | |
| | 100-101 | 0-15 | MINOR CYCLE TIME | | | |
| *OTHER* | | | *REPEAT MINOR CYCLES 2-8 (24 TIMES)* | | | |

*See MIU Hardware Specification for details.

### 4.3.3. AIP Command Verification Queue

Each Table Queue Slot contains an AIP Command Verification (CV) Word. Each CV Word defines Errors, Warnings, and the Command Sequence Number (CSN) of the received command. Warnings are not fatal but errors might be, plus an error normally indicates a command not executed. See the table below for the format of the Command Verification Words for both the AIP and TIP. Refer to section 4.4.1 Command Verification Message Definition for the definitions of these CV words.

**TABLE 4.3.3-1 - AIP Telemetry Bytes 98-101 – AIP and TIP CV QUE Dump Format**

| *QUEUE SLOT* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* | | | |
|---|---|---|---|---|---|
| | | *8* | *9* | *00* | *01* |
| N/A | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 0-1 | 1 | COMMAND VERIFICATION WORD* | | COMMAND VERIFICATION WORD | |
| 2-3 | 2 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 4-5 | 3 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 6-7 | 4 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 8-9 | 5 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 10-11 | 6 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 12-13 | 7 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 14-15 | 8 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 16-17 | 9 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 18-19 | 10 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 20-21 | 11 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 22-23 | 12 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 24-25 | 13 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 26-27 | 14 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 28-29 | 15 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 30-31 | 16 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 32-33 | 17 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 34-35 | 18 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 36-37 | 19 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 38-39 | 20 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 40-41 | 21 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 42-43 | 22 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 44-45 | 23 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 46-47 | 24 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| 48-49 | 25 | COMMAND VERIFICATION WORD | | COMMAND VERIFICATION WORD | |
| *N/A* | *26-79* | ***FILLER*** | | ***FILLER*** | |

*Refer to Flight Command Verification section for all CV word definitions

### 4.3.4. TIP Command Verification Queue

This TIP CV Queue format is defined in the Table shown above and is identical to the AIP Queue Table.

### 4.3.5. Memory Scrub Address Table

Each Table Slot contains the Block Enable Flag, Most Significant (MS) Block Start Address and Least Significant (LS) Block Start Address, and Most Significant (MS) Block End Address and Least Significant (LS) Block End Address. See Table below for a definition of the Memory Scrub Table.

**TABLE 4.3.5-1 - MIU Slow Dump Submode - Memory Scrub Table Dump Format**

| *TABLE SLOT* | *MINOR CYCLE* | *AIP TELEMETRY FRAME BYTES* | | | |
|---|---|---|---|---|---|
| | | *8* | *9* | *00* | *01* |
| N/A | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 0 | 1 | BLOCK ENABLED | | MS BLOCK START ADDRESS | |
| | 2 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 3 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 1 | 4 | MS BLOCK START ADDRESS | | LS BLOCK START ADDRESS | |
| | 5 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| 2 | 6 | BLOCK ENABLED | | MS BLOCK START ADDRESS | |
| | 7 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 8 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 3 | 9 | MS BLOCK START ADDRESS | | LS BLOCK START ADDRESS | |
| | 10 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| 4 | 11 | BLOCK ENABLED | | MS BLOCK START ADDRESS | |
| | 12 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 13 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 5 | 14 | MS BLOCK START ADDRESS | | LS BLOCK START ADDRESS | |
| | 15 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| 6 | 16 | BLOCK ENABLED | | MS BLOCK START ADDRESS | |
| | 17 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 18 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 7 | 19 | MS BLOCK START ADDRESS | | LS BLOCK START ADDRESS | |
| | 20 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| 8 | 21 | BLOCK ENABLED | | MS BLOCK START ADDRESS | |
| | 22 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 23 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 9 | 24 | MS BLOCK START ADDRESS | | LS BLOCK START ADDRESS | |
| | 25 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| 10 | 26 | BLOCK ENABLED | | MS BLOCK START ADDRESS | |
| | 27 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 28 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 11 | 29 | MS BLOCK START ADDRESS | | LS BLOCK START ADDRESS | |
| | 30 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| 12 | 31 | BLOCK ENABLED | | MS BLOCK START ADDRESS | |
| | 32 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 33 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 13 | 34 | MS BLOCK START ADDRESS | | LS BLOCK START ADDRESS | |
| | 35 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| 14 | 36 | BLOCK ENABLED | | MS BLOCK START ADDRESS | |
| | 37 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 38 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 15 | 39 | MS BLOCK START ADDRESS | | LS BLOCK START ADDRESS | |

## TABLE 4.3.5-1 - MIU Slow Dump Submode - Memory Scrub Table Dump FORMAT (Cont.)

| *TABLE SLOT* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* | | | |
|---|---|---|---|---|---|
| | | *8* | *9* | *00* | *01* |
| | 40 | 1S BLOCK END ADDRESS | | S BLOCK END ADDRESS | |
| 16 | 41 | ·LOCK ENABLED | | 1S BLOCK START ADDRESS | |
| | 42 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 43 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 17 | 44 | 1S BLOCK START ADDRESS | | S BLOCK START ADDRESS | |
| | 45 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| 18 | 46 | ·LOCK ENABLED | | 1S BLOCK START ADDRESS | |
| | 47 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 48 | LS BLOCK END ADDRESS | | BLOCK ENABLED | |
| 19 | 49 | 1S BLOCK START ADDRESS | | S BLOCK START ADDRESS | |
| | 50 | MS BLOCK END ADDRESS | | LS BLOCK END ADDRESS | |
| *N/A* | *51-79* | *FILLER* | | *FILLER* | |

## TABLE 4.3.5-2 - MIU Slow Dump Submode - Memory Scrub Table Dump Definition

| *MINOR CYCLE* | *:YTE* | *BITS* | *DESCRIPTION* |
|---|---|---|---|
| 1 | 8-99 | 0-14 | RESERVED |
| | | 15 | BLOCK ENABLED |
| | 100-101 | 0-15 | MOST SIGNIFICANT 4 BITS OF BLOCK START ADDRESS |
| 2 | 8-99 | 0-15 | LEAST SIGNIFICANT 16 BITS BLOCK START ADDRESS |
| | 100-101 | 0-15 | MOST SIGNIFICANT 4 BITS BLOCK END ADDRESS |
| | 8-99 | 0-15 | LEAST SIGNIFICANT 16 BITS BLOCK END ADDRESS |
| 3 | 100-101 | 0-14 | RESERVED |
| | | 15 | BLOCK ENABLED |
| 4 | 8-99 | 0-15 | MOST SIGNIFICANT 4 BITS OF BLOCK START ADDRESS |
| | 100-101 | 0-15 | LEAST SIGNIFICANT 16 BITS BLOCK START ADDRESS |
| 5 | 8-99 | 0-15 | MOST SIGNIFICANT 4 BITS BLOCK END ADDRESS |
| | 100-101 | 0-15 | LEAST SIGNIFICANT 16 BITS BLOCK END ADDRESS |
| *OTHERS* | | | *REPEAT MINOR CYCLES 1-5 (9 TIMES)* |

### 4.3.6. Memory Checksum Address Table

Each Table Slot contains the Block Enable Flag, Most Significant (MS) Block Start Address and Least Significant (LS) Block Start Address, and Most Significant (MS) Block End Address and Least Significant (LS) Block End Address and Expected Checksum Value.

**TABLE 4.3.6-1 - MIU Slow Dump Submode - Memory Checksum Dump Format**

| *TABLE SLOT* | *MINOR CYCLE* | *AIP TELEMETRY BYTES* | | | |
|---|---|---|---|---|---|
| | | *8* | *9* | *00* | *01* |
| N/A | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 0 | 1 | ·LOCK ENABLED | | 1S BLOCK START ADDRESS | |
| | 2 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 3 | LS BLOCK END ADDRESS | | EXPECTED CHECKSUM | |
| 1 | 4 | ·LOCK ENABLED | | 1S BLOCK START ADDRESS | |
| | 5 | LS BLOCK START ADDRESS | | MS BLOCK END ADDRESS | |
| | 6 | LS BLOCK END ADDRESS | | EXPECTED CHECKSUM | |
| 2-19 | 7-58 | | | | |
| | *8-59* | *continue from slot 1 in same format* | | *continue from slot 1 in same format* | |
| | *9-60* | *18 x more times (3 minor cycles/slot)* | | *18 x more times (3 minor cycles/slot)* | |
| *N/A* | *61-79* | *'ILLER* | | *'ILLER* | |

**TABLE 4.3.6-2 - MIU Slow Dump Submode - Memory Checksum Dump Definition**

| *MINOR CYCLE* | *'YTE* | *BITS* | *DESCRIPTION* |
|---|---|---|---|
| 1 | 8-99 | 0-14 | RESERVED |
| | | 15 | BLOCK ENABLED |
| | 100-101 | 0-15 | MOST SIGNIFICANT 4 BITS BLOCK START ADDRESS |
| 2 | 8-99 | 0-4 | LEAST SIGNIFICANT 16 BITS BLOCK START ADDRESS |
| | 100-101 | 0-15 | MOST SIGNIFICANT 4 BITS BLOCK START ADDRESS |
| 3 | 8-99 | 0-4 | LEAST SIGNIFICANT 16 BITS BLOCK END ADDRESS |
| | 100-101 | 0-15 | EXPECTED CHECKSUM |
| *OTHERS* | | | *REPEAT MINOR CYCLES 1-3 (19 TIMES)* |

### 4.3.7. Bus Utilization Table

Each Table Slot contains the Transaction Enabled Flag, Transaction Type, and End Minor Cycle Number. See Table below for a full definition of the Bus Utilization Table Entry.

## TABLE 4.3.7-1 - MIU Slow Dump Submode - Bus Utilization Table Dump Format

| *SCAN P/SCHED* | *MINOR CYCLE* | ***AIP TELEMETRY FRAME BYTES*** | | | |
|---|---|---|---|---|---|
| | | ***8*** | ***9*** | ***00*** | ***01*** |
| N/A | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 0/0 | 1 | RANSACTION SLOT ENABLED | | RANSACTION TYPE | |
| | 2 | ENDING MINOR CYCLE | | TRANSACTION SLOT ENABLED | |
| 0/1 | 3 | RANSACTION TYPE | | NDING MINOR CYCLE | |
| 0/2 | 4 | TRANSACTION SLOT ENABLED | | TRANSACTION TYPE | |
| | 5 | ENDING MINOR CYCLE | | TRANSACTION SLOT ENABLED | |
| 0/3 | 6 | RANSACTION TYPE | | NDING MINOR CYCLE | |
| 0/4 | 7 | TRANSACTION SLOT ENABLED | | TRANSACTION TYPE | |
| | 8 | ENDING MINOR CYCLE | | TRANSACTION SLOT ENABLED | |
| 0/5 | 9 | RANSACTION TYPE | | NDING MINOR CYCLE | |
| 0/6 | 10 | TRANSACTION SLOT ENABLED | | TRANSACTION TYPE | |
| | 11 | ENDING MINOR CYCLE | | TRANSACTION SLOT ENABLED | |
| 0/7 | 12 | RANSACTION TYPE | | NDING MINOR CYCLE | |
| 0/8 | 13 | TRANSACTION SLOT ENABLED | | TRANSACTION TYPE | |
| | 14 | ENDING MINOR CYCLE | | TRANSACTION SLOT ENABLED | |
| 0/9 | 15 | TRANSACTION TYPE | | ENDING MINOR CYCLE | |
| *1/0-THRU* | *16 - thru* | *Repeat above for scan 1 (10x, 15 cycles)* | | *Repeat above for scan 1 (10x, 15 cycles)* | |
| *1/9* | *30* | | | | |
| *2/0-THRU* | *31 - thru* | *Repeat above for scan 2 (10x, 15 cycles)* | | *Repeat above for scan 2 (10x, 15 cycles)* | |
| *2/9* | *45* | | | | |
| *N/A* | *46-79* | ***FILLER*** | | ***FILLER*** | |

## TABLE 4.3.7-2 - MIU Slow Dump Submode - Bus Utilization Table Dump Definition

| *MINOR CYCLE* | *YTE* | *BITS* | *ESCRIPTION* | *TATE / DEFINITION* |
|---|---|---|---|---|
| 1 | 8-99 | 0-14 | RESERVED | |
| | | 15 | TRANSACTION SLOT ENABLED | |
| | 100-101 | 0-11 | RESERVED | |
| | | 12-15 | TRANSACTION TYPE | 000 – NIL |
| | | | | 001 – Miscellaneous<br>010 – HK Telemetry<br>011 – SCI Telemetry<br>100 – Command<br>101 – Undefined<br>110 – Undefined<br>111 – Undefined |
| 2 | 8-99 | 0-15 | ENDING MINOR CYCLE | |
| | 100-101 | 0-14 | RESERVED | |
| | | 15 | TRANSACTION SLOT ENABLED | |
| 3 | 8-99 | 0-11 | RESERVED | |
| | | 12-15 | TRANSACTION TYPE | *000 – 111 same as above* |
| | 100-101 | 0-15 | ENDING MINOR CYCLE | |
| ***OTHERS*** | | | ***REPEAT MINOR CYCLES 1-3 (14 TIMES)*** | |

### 4.3.8. Bus Error Tables

Each Table Slot contains the Major Cycle, Minor Cycle, Error Address, Error Type, and Error Word. See Table for a full definition of the Bus Error Table Entry.

**TABLE 4.3.8-1 - MIU Slow Dump Submode - Bus Error Table Dump Format**

| *TABLE SLOT* | *IAJOR 'YCLE* | *MINOR CYCLE* | *AIP TELEMETRY FRAME BYTES* | | | |
|---|---|---|---|---|---|---|
| | | | *8* | *9* | *00* | *01* |
| N/A | n | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 0 | n | 1 | IAJOR CYCLE | | | |
| | | 2 | MINOR CYCLE | | ERROR WORD ADDRESS | |
| | | 3 | ERROR TYPE | | ERROR WORD | |
| 1 | n | 4 | IAJOR CYCLE | | | |
| | | 5 | MINOR CYCLE | | ERROR WORD ADDRESS | |
| | | 6 | ERROR TYPE | | ERROR WORD | |
| 2 - 26 | n | 7- 79 | *epeat above format for slots 2-26 (minor cycles 7-79) Major cycle = n* | | | |
| N/A | n+1 | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 26 - 52 | n+1 | 1- 79 | *Repeat above format for slots 26-52 (minor cycles 1-79) Major cycle = n+1* | | | |
| N/A | n+2 | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 52 - 78 | n+2 | 1- 79 | *Repeat above format for slots 52-78 (minor cycles 1-79) Major cycle = n+2* | | | |
| N/A | n+3 | 0 | **PHYSICAL TABLE ADDRESS** | | | |
| 79 - 99 | n+3 | 1- 63 | *Repeat above format for slots 79-99 (minor cycles 1-63) Major cycle = n+3* | | | |
| N/A | n+3 | 64- 79 | *FILLER* | | *FILLER* | |

**TABLE 4.3.8-2 - MIU Slow Dump Submode - Bus Error Table Dump Definition**

| *MINOR CYCLE* | *AIP BYTE* | *BITS* | *DESCRIPTION* | *STATE / DEFINITION* |
|---|---|---|---|---|
| 1 | 8-101 | 0-31 | MAJOR CYCLE COUNT | LSB = 8 SEC |
| 2 | 98-99 | 0-15 | MINOR CYCLE COUNT | LSB = 0.1 SEC |
| | 00-101 | 0-15 | ADDRESS OF ERRONEOUS COMMAND BLK | |
| 3 | 98-99 | 0 | RESERVED | |
| | | 1 | STATUS WORD ERROR | |
| | | 2 | RT ADDRESS ERROR | |
| | | 3 | CONTROL WORD MESSAGE ERROR | |
| | | 4-15 | RESERVED | |
| | 00-101 | 0-4 | RT ADDRESS | |
| | | 5 | SW MESSAGE ERROR | |
| | | 6 | INSTRUMENTATION | |
| | | 7 | SERVICE REQUEST | |
| | | 8 | CONTROL WORK MESSAGE ERROR | |
| | | 9-10 | RESERVED | |
| | | 11 | BROADCAST COMMAND RECEIVED | |
| | | 12 | BUSY | |
| | | 13 | SUBSYSTEM FLAG | |
| | | 14 | DYNAMIC BUS ACCEPTANCE | |
| | | 15 | TERMINAL FLAG | |

## 4.4. Flight Command Verification Message Format

### 4.4.1. Flight Software Command Verification Message Definition

Command Verification (CV) Status is similar to the Bootstrap CV but is found in TIP telemetry byte 102 of minor frames 3-4 and again in 29-30 and 55-56 for Normal TIP Telemetry (This TLM point is MIU# 5). In TIP Engineering Mode, CV Words are found in minor frames 7-8 only. This TLM point is one of the more important items found in telemetry since it will indicate the validity and status of the commands sent to the MIU.

The format for CV Status is shown below and the definitions are listed in table 4.4.2-1. There are no Reply Words as in the Bootstrap CV. The CV Status communicates errors, warnings, and the command sequence number of the last command. Both Warnings and Errors will appear in a single CV Status word.

| BITS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ERROR | | | | WARNINGS | | | | COMMAND SEQUENCE NUMBER | | | | | | | |

### 4.4.2. CV Errors

CV Errors are usually fatal for the command and it can be expected that the command associated with the Command Sequence Number was not executed. The exception would be the condition "CV Queue is idle (F hex)". This would be the normal "waiting for next command" condition, not really an error and when a valid command is accepted for the MIU or MHS the "No Error (0 hex)" is seen for only one scan cycle (2.6 seconds) and then it would go back to the "CV Queue is idle (F hex)" state.

**TABLE 4.4.2-1 – Active mode CV Error Codes**

| ERROR DESCRIPTION | Hex | CV WORD BITS | | | |
|---|---|---|---|---|---|
| | No. | 0 | 1 | 2 | 3 |
| No Error | 0 | 0 | 0 | 0 | 0 |
| Ground Checksum does not match | 1 | 0 | 0 | 0 | 1 |
| OPCODE for MIU Invalid | 2 | 0 | 0 | 1 | 0 |
| Data Word Length Error | 3 | 0 | 0 | 1 | 1 |
| Range for Opcode is out-of-bounds | 4 | 0 | 1 | 0 | 0 |
| Address for Opcode is out-of-bounds | 5 | 0 | 1 | 0 | 1 |
| Command destination not MIU or MHS | 6 | 0 | 1 | 1 | 0 |
| Attempted to load non-existent table | 7 | 0 | 1 | 1 | 1 |
| Subsystem Error – command not executed | 8 | 1 | 0 | 0 | 0 |
| MHS Command Queue Full | 9 | 1 | 0 | 0 | 1 |
| Undefined | A | 1 | 0 | 1 | 0 |
| Undefined | B | 1 | 0 | 1 | 1 |
| Undefined | C | 1 | 1 | 0 | 0 |
| Undefined | D | 1 | 1 | 0 | 1 |
| Command rejected after Exception | E | 1 | 1 | 1 | 0 |
| CV Queue is idle | F | 1 | 1 | 1 | 1 |

### 4.4.3. CV Warnings

CV Warnings, although not fatal since the command has been executed anyway, does indicate potential problems that may impact the next command or expected result. For instance, an Out-of-Sequence CSN could indicate a "lost or rejected" command from a previous transmission, although for a grouped command sequence this may be normal. A queue overflow would indicate that a previous command(s) has not yet been processed.

**TABLE 4.4.3-1 – Active mode CV Warning Codes**

| CV WARNING DESCRIPTION | Hex No. | CV WORD BITS | | | |
|---|---|---|---|---|---|
| | | 4 | 5 | 6 | 7 |
| No Warning | 0 | 0 | 0 | 0 | 0 |
| Out-of-Sequence CSN | 1 | 0 | 0 | 0 | 1 |
| This CV Queue Overflowed | 2 | 0 | 0 | 1 | 0 |
| Out-of -Sequence CSN & CV Overflow | 3 | 0 | 0 | 1 | 1 |
| Uplink Queue Reset | 4 | 0 | 1 | 0 | 0 |
| Out-of -Sequence CSN & Uplink Reset | 5 | 0 | 1 | 0 | 1 |
| Uplink Queue Reset & CV Queue Overflow | 6 | 0 | 1 | 1 | 0 |
| All Three conditions | 7 | 0 | 1 | 1 | 1 |

# 5. MHS COMMANDS

This document section is intended to show the formulation of the MHS command packets and to acquaint the reader to the various command types for the MHS instrument. The MHS command description is a set of excerpts from the MHS 'JA063' document along with any related MIU functional description.

The MHS is commanded via the MIU command data packets as described earlier in this document. Table 5-1 is shown below to illustrate the construction of the MHS commands. The reader is encouraged to read the MHS document 'MHS-TN-JA063-MMP' for further MHS command information..

An example Set Mode command as seen at the MIU interface:

**TABLE 5-1 - Set Mode, Self Test, Repeating Fixed Pattern**

Bit: 0 … 15

| | | | | | |
|---|---|---|---|---|---|
| Checksum | Checksum | | | | |
| (0..7) | CSN | | Reserved | | (8..15) |
| (0..5) | Dest ID= 00001 | Length = 1 (16-bit word) | | | (6..15) |
| 1 | CC hex | 0101 | 1 | 001 | |
| | Mode Code | Self Test | Repeat | Fixed Pat. | |

The fields shown are the same as described in Section 3.1 of this document, but the destination is set to MHS (00001) and length is one (1) 16-bit word because this is a MHS command word.

For all MHS commands the Destination ID will be equal to one (1) and all data after the length field will be sent to the MHS unchanged by the MIU. A CCSDS packet format is added as six (6) words before the MHS Command, Fill words are added to pad until seven (7) words are included and a Packet Error Control word (Parity Checksum) is added at the end by the MIU.

## 5.1. MHS Command Packets

Command Packets instruct the MHS to change state or provide information for all normal ground tests or on orbit operations. The following Table shows all commands:

**TABLE 5.1-1 – MHS CMD PACKETS**

| Command Type | Cmd Code (hex) | Total Size (bytes) (Including Cmd Code) | MIU Packet Length |
|---|---|---|---|
| Set Mode (MH_STM) | CC | 2 | 1 |
| Switch Command (MH_SWC) | 3C | 2 | 1 |
| Read Telemetry(MH_RTM) | 36 | 2 | 1 |
| Set Fixed View Position(MH_FVP) | 66 | 4 | 2 |
| Fixed View Step(MH_FVS) | 6C | 2 | 1 |
| Load Memory(MH_LDM) | 33 | 14 | 7 |
| Set Time Code (MH_STC) | 69 | 8 | 4 |
| Load Table Data (MH_LTD) | 63 | 10 | 5 |

Several commands are sent by the MIU to collect data for the AIP and TIP Telemetry. All of this is handled internally by the MIU via Bus Utilization Table (BUT).

| Command Type | Command Code (hex) | Parameters (bytes) |
|---|---|---|
| Request HK TLM Packet (1) | C3 | 2 |
| Request Science Data Packet (1) | C3 | 2 |
| Request Memory Data Packet (2) | 39 | 4 |
| Request Extended Memory Data Packet (2) | 39 | 4 |

(1) HK and Science Data packets are requested automatically by the MIU every scan period (8/3 sec). This is part of the MIU Bus Utilization Table implementation. If these commands were sent from the ground, incorrectly then the MHS could be asked to provide more than one packet per scan, which may not be operationally possible for the MHS.

**Note: NAGE or Ground Commanding Should Not Use These (1) Commands.**

(2) The Request Memory Data Packet & the Request Extended Memory Data Packet share the same 'command code'. This imposes some differences in commanding the MHS to send the appropriate data packet. Commands to set MIU Bus Mode to SCI data will result in an extended SCI Memory Data Packet while setting the Bus Mode to HK will result in the data being dumped into the HK TLM

### 5.1.1. Set Mode

The Set Mode command (8 bits), Opcode CC Hex, is followed by two 4-bit parameters for a total 16-bits. The MIU Packet Length Field is 1 (one 16-bit word). All spares will be filled in by the MIU. The command is laid out as follows:

<table>
<tr><td>LSB</td><td colspan="2">8 BITS</td><td>MSB</td></tr>
<tr><td colspan="4">Command Code = CC hex</td></tr>
<tr><td colspan="2">Mode Code=0000 to 1111</td><td colspan="2">Submode Code=0000 to 0111</td></tr>
</table>

The Mode Field includes the following options:

| Mode Field | Code |
|---|---|
| Power-On | 0000 |
| warm-up | 0001 |
| Standby | 0010 |
| Scan | 0011 |
| Fixed View | 0100 |
| Self-Test | 0101 |
| Safeing | 0110 |
| Unused | 0111 |
| | ..... |
| Reserved | 1111 |

The Submode Code is used only in Self-Test Mode (otherwise the field has undefined contents), to identify the type of self-test to be performed. The Submode Code formats are as follows:

| 4 bit | 5 bit | 6 bit | 7 bit |
|---|---|---|---|
| Repeat Bit | Self-Test code | | |

The Repeat Bit is set to Zero (0) if the test is to be done only once. It is set to One (1) if it is to be repeated until commanded to calling mode.

Self-Tests available is:

| Self-Test Code | Self Test Name |
|---|---|
| 0 | PIE Functions |
| 1 | Fixed Pattern |
| 2 | Watchdog |
| 3 | Motor |
| 4 | PRT Calibration |
| 5 – 7 | Unused |

It cannot be overemphasized that there is a down side to the use of the self-test features of the instrument. Both HK & Science housekeeping telemetry is not available during the execution of a self-test. During such testing, the only 'health & safety' telemetry available from the MHS are the three 'hardware' temperature telemetry items that are physically wired to the MIU. Any 'self tests' on orbit must be performed during a real time pass and care should be taken to end the 'self test' before losing ground contact for that pass.

### 5.1.2. Switch Command

This allows operation of various switches in the MHS as referenced in MHS-TN-JA063-MMP. The MIU Packet Length Field is 1 (one 16-bit word). All spares will be filled in by the MIU. The Command Code is 3C hex and uses two different formats.

The first format is used for Type 01 Switch Commands, High Level commands (e.g., Pulsed Relay commands.) See reference MHS-TN-JA063-MMP Figure 6.1-1 for details.

| MSB | 8 BITS | LSB |
|---|---|---|
| | Command Code = 3C hex | |
| Type = 01 | Switch Channel Number | |

Commands a 01:n where n is the Switch Channel number.

For Type 10 and 11 the format is as below:

| MSB | | 8 BITS | LSB |
|---|---|---|---|
| | | Command Code = 3C hex | |
| Type = 10 /11 | Level | Switch Channel Number | |

Type 10 binary are 'Steady State" commands (e.g., FET Control) where Commands 2:n (see Figure 6.2-1 in MHS-TN-JA063-MMP. Level 0 is a switch OFF and Level 1 is Switch ON.

Type 11 binary are 'BIM' register' commands (for SCE, SPE function)
Commands 3:n (see Figure 6.3-1 in MHS-TN-JA063-MMP). Level 0 is clear register, and Level 1 is set register.

### 5.1.3. Read Telemetry

Read telemetry selects the channel number from which telemetry will be read. The MIU Packet Length Field is 1 (one 16-bit word). All spares will be filled in by the MIU.

| MSB | 8 BITS | LSB |
|---|---|---|
| | Command Code = 36 hex | |
| Type = 01 | Telemetry Channel Number | |

The Type corresponds to the Telemetry Channel Number prefix as shown in Figures 5.1-1 – 5.1-3, and 5.2-1 and 5.3-1 in MHS-TN-JA063-MMP. The Channel Number corresponds to those listed in the referenced tables.

(The Read Telemetry command is not available for Type 6 (i.e., PRT data, and channels 6:1 to 6:8)

### 5.1.4. Set Fixed View Position

This command will set the Fixed View Position. The MIU Packet Length Field is 2 (two 16-bit words). All spares will be filled in by the MIU. The Command Code is 66 Hex.

| MSB | 8 BITS | LSB |
|---|---|---|
| | Command Code = 66 hex | |
| | Unused | |
| | Pointing Angle MS Byte | |
| | Pointing Angle LS Byte | |

The Pointing Angle is an absolute position, measured in degrees where one LSB = 0.01 degrees. Angles greater than 359.99 are interpreted as modulo 360.

### 5.1.5. Fixed View Step

The MIU Packet Length Field is 1 (one 16-bit word). All spares will be filled in by the MIU.

| MSB | 8 BITS | LSB |
|---|---|---|
| | Command Code = 6C hex | |
| Step Direction | Step Size | |

Step Direction is one bit. If equal to zero (0) it indicates forward (i.e., direction of rotation for Scan Mode Profile). Set Direction one (1) indicates backward rotation.

Step Size is seven (7) bits and represents a relative step measured in degrees, from the current pointing position. Step size one LSB = 1/9 degrees (i.e., 1/10th of a pixel).

### 5.1.6. Load Memory

This command allows memory to be read into the MHS. The command is 33 hex and is followed by a 24-bit Start Address and then four 16-bit data words and a 16-bit Checksum. The MIU Packet Length Field is 7 (seven 16-bit words). All spares will be filled in by the MIU.

| MSB | 8 BITS LSB |
|---|---|
| 1 | Command Code = 33 hex |
| 2 | Start Address MS Byte |
| 3 | Start Address Middle Byte |
| 4 | Start Address LS Byte |
| 5 | Data Word 1 LS Byte |
| 6 | Data Word 1 LS Byte |
| 7 | Data Word 2 LS Byte |
| 8 | Data Word 2 LS Byte |
| 9 | Data Word 3 LS Byte |
| 10 | Data Word 3 LS Byte |
| 11 | Data Word 4 LS Byte |
| 12 | Data Word 4 LS Byte |
| 13 | Checksum LS Byte |
| 14 | Checksum LS Byte |

The Checksum is the exclusive-OR of all the bytes through Data Word 4 (Bytes 1 to 12).

### 5.1.7. Set Time Code

This command will set the Coarse and Fine Time in the MHS. The MIU Packet Length Field is 4 (four 16-bit words). All spares will be filled in by the MIU.

| MSB 8 BITS LSB |
|---|
| Command Code = 69 hex |
| Unused |
| Course Time MS Byte |
| Course Time |
| Course Time |
| Course Time LS Byte |
| Fine Time MS Byte |
| Fine Time LS Byte |

Coarse time is a 32-bit value (LSB = 1 second). Fine Time is a 16-bit value (LSB = $2^{-16}$ seconds). Instrument Time is set to the defined value at the net eight second pulse event.

### 5.1.8. Load Table Data

This command allows loading a table with data at a specified reference point. The MIU Packet Length Field is 5 (five 16-bit words). All spares will be filled in by the MIU.

| MSB | 8 BITS | LSB |
|---|---|---|
| Command Code = 63 hex | | |
| Unused | Table Reference | |
| Unused | Data Reference | |
| Data Word 1 | | |
| Data Word 2 | | |
| Data Word 3 | | |
| Data Word 4 | | |
| Checksum MS Byte | | |
| Checksum LS Byte | | |

The Table Reference points to one of the following tables. All other values a not valid.

| Code | Database Table |
|---|---|
| 0000 | Instrument Configuration Table (ICT) |
| 0001 | Telemetry Limits Table (TLT) |
| 0010 | Scan Control Table (SCT) |
| 0011 | DC offsets Table (DOT) |

The Data Reference is a pointer from 0 to 4095. It is used to select the required entry in the table. For Data Table representations, see Appendices A, B, C, and D in MHS-TN-JA063-MMP.

The Checksum is the exclusive-OR of all the bytes through Data Word 4 (Bytes 1 to 7).

## 6. APPENDIX A: ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 1553B | Military Standard for a Multiplexed data bus |
| AC | Alternating Current |
| Adrs | Address |
| AIP | AMSU Information Unit |
| BCRTM | Bus Controller Remote Terminal Module |
| BOL | Beginning -of -Life |
| BPS | Bits per Second |
| CCSDS | Consultative Committee for Space Data Systems |
| CIU | Controls Interface Unit |
| CLK | Clock |
| CPU | Central Processing Unit |
| CS | Condition Status |
| CV | Command Verification word |
| C&T | Command and Telemetry |
| D/A | Digital to Analog |
| DC | Direct Current |
| DEF | Double Error Fault |
| Enab | Enable |
| EDAC | Error Detection and Correction |
| EOL | End-of-Life |
| EPC | Electronic Power Converter |
| EXT | External |
| Extclk | External Clock |
| FT | Fault Register |
| FIFO | First in first out |
| FW | Firmware |
| I/O | Input/Output |
| IOADD | Input Output Address |
| IODATA | Input Output Data |
| ISR | Interrupt Service Request |

| | |
|---|---|
| kHz | Kilohertz |
| KIPS | Kilo Instructions per Second |
| LMSSC | Lockheed Martin Space Systems Co. |
| LE | Leading Edge |
| LSB | Least Significant Bit |
| MA | Milliampere |
| MAS281 | Marconi 1750 Chip Set |
| MCST | Memory Check Bit Strobe |
| MDST | Memory Data Strobe |
| MHS | Microwave Humidity Sounder |
| MHz | Megahertz |
| MIU | Microwave Humidity Sounder Interface Unit |
| MMU | Memory Management Unit |
| mF | Microfarad |
| MSB | Most Significant Bit |
| Msec | Millisecond |
| MSO | Missiles & Space Operations |
| ns | Nanosecond |
| NOAA | National Oceanic and Atmospheric Administration |
| PADD | Physical Address |
| PIB | Parallel Input Buffer |
| PLL | Phase Lock Loop |
| POB | Parallel Output Buffer |
| POR | Power-On-Reset |
| PPM | Pulses per Minute |
| PSE | Power Supply Electronics |
| RAM | Random Access Memory |
| ROM | Read Only Memory |
| S/C | Spacecraft |
| SCP | Standard Controls Processor |
| SEF | Single Error Fault |
| SIB | Serial Input Buffer |
| SOB | Serial Output Buffer |

| | |
|---|---|
| STE | Special Test Equipment |
| SW | Software |
| SYNC | Synchronous |
| TIP | TIROS Information Processor |
| V | volt |
| XSU | Cross-strap Unit |

## 7. APPENDIX B: MIU SOFTWARE NOTES - HERITAGE

MIU Ada and Assembly code sources are available on CD-ROM, MIU STE 0010, 09059693309 1. Full analysis reports from the tool "Understand for Ada." are included on CD-ROM.

Reports included are as follows:

1. Data Dictionary
2. Program Unit Cross Reference
3. Object Cross Reference
4. Type Cross Reference
5. Declaration Tree
6. Invocation Tree
7. Simple Invocation Tree
8. With Tree
9. Simple With Tree
10. Generic Instantiation
11. Exception Cross Reference
12. Renames Report
13. Program Unit Complexity
14. Project Metrics Report
15. Program Unit Metrics
16. File Metrics
17. Unused Objects

Unused Types

18. Unused Program Units
19. Withs Not Needed

```
*********************************************************************************
                          ASTRO SPACE DIVISION - TIROS
*********************************************************************************

This file contains key information and instructions regarding the firmware for the TIROS MHS
Interface Unit (MIU).  This document has been created to provide a good starting point for
understanding how the software was constructed.

*********************************************************************************

INTRODUCTION

The purpose of the MIU is to provide a data interface between the Microwave Humidity Sounder
(MHS) and the TIROS spacecraft Command Interface Unit (CIU).  The MIU sends commands and
collects telemetry from the MHS using the MIL-STD-1553B bus communications protocol.  The MIU
receives commands (both internal and MHS) and sends telemetry to the CIU using serial I/O.
The heart of the MIU is the Marconi 1750A chipset, 64 K words of PROM, and 160K words of RAM.
The United Technologies UTC1553 chipset is the hardware supporting the 1553B bus protocol.
```

The MIU firmware is comprised of multiple modules containing instructions and operands in the machine language format of the 1750A microprocessor. The firmware consists of two separate software functions, bootstrap and application. Both are stored in the PROM. The 64 K words of PROM are mapped one-to-one with the lower 64 K words of RAM. At startup, the bootstrap software is copied from PROM to RAM and operates from RAM. The bootstrap accepts commands and sends telemetry (MIU only) in support of loading, modifying, and activating the MIU application software. The application software also operates from RAM.

The source code for the bootstrap is written in TARTAN Assembler. The source code for the application software is written in Ada, TARTAN Assembler, and ITS Assembler. The TARTAN Ada/1750A Cross-Compiler/Toolset v4.3.3 was used in the creating the MIU firmware. The Run Time System has also been provided by TARTAN.

*******************************************************************************

DIRECTORIES AND FILES

The bulk of the firmware, tools, and documentation resides on Astro Space's (and

Lockheed-Martin's) Unix network. Formal (i.e. controlled) and informal (viewgraph packages and memorandums) are in Interleaf format. For the time being, they reside in Kevin Borusiewicz's Interleaf desktop (kborusie/desktop5).

The TARTAN toolset has it's home in /sw/tartan/1750a/v4.3.3. The original run time system library and some of the source files are in /sw/tartan/1750a/v4.3.3/rt_exmem. The remaining source files for the run time are in /sw/tartan/1750a/v4.3.3/rt_64k_src.

The source code for the bootstrap software is in the directory /work/miu/asm. The source code for the application software resides in /work/miu/src. The Run Time System object library, and the Source for the Run Time System components which were tailored for the MIU reside in /work/miu/rts.

The remaining tools reside on the VAX ASTRO Cluster Z. These tools are mostly for test support. This is the platform used for running the MIU version of the Software Development Facility (SDF), and post-processing tools.

*******************************************************************************

The MIU Computer Software Configuration Item (CSCI) consists of three main 'pieces'. The first piece is the Bootstrap software, which is a stand-alone item, developed completely in 1750A Assembly Language, and converted to machine code using the TARTAN Assembler. The source file(s) for the Bootstrap reside in kmacmill/miu/asm. Originally, the Bootstrap software consisted of several modules (heritage from GPS). Due to a shortcoming of the linker, these modules had to be combined into one file. The single file is the version actually linked into the software, however it is exactly the same in form, fit, and function to the individual modules.

In the kmacmill/miu/asm directory there is a Make file which will create a stand-alone version of the Bootstrap.

The second piece is the Run Time System, provided by TARTAN. The Static Expanded Memory version is used for this project. TARTAN encourages modification of certain RTS components, and provides sufficient documentation towards that end.

Copies of the 64k RTS (madartl.tlib) and the Static Expanded Memory RTS (semrtl.tlib) exist in the kmacmill/miu/rts directories. The 64k RTS was only used for initial test. The SEM version is for flight use. The RTS modules that have been modified for the MIU firmware also reside in this directory. They are:

```
INTVEC.asm     - Hardware Initialization ,Start-up
ARTEXCNAME.asm - Exception Names
ARTUNWIND.asm  - Exception Handling
EXDEFS.asm     - Defines Interrupt Masks and Stack Sizes
SIMPLEIO.asm   - Console I/O
MADAROOT.asm   - RTS and Ada Start-up
```

In addition, TARTAN provides a template for hooking 1750A Interrupts to Ada coded Interrupt Service Routines. These files, also written in 1750A Assembler, all end with the extension .DASM.

The third and final piece is the Ada coded application software, which runs on top of the RTS. All of the Ada packages created for the MIU firmware reside in kmacmill/miu/src.

A Make file has been created to compile and link the software, and convert the resulting output to an executable that can be used with the Software Development Facility (SDF). The Make file is used rather than attempting closure, in order to make the compilation efficient (ie, single pass).

A Make file has also been created to re-build the RTS, should that become necessary.

*******************************************************************************

Directory Structures

The MIU directory contains several subdirectories. The key subdirectories and their purpose are listed below:

/work/miu/asm -

Assembler code for Bootstrap and Application firmware, original (module version) of Bootstrap, Make file for standalone version of Bootstrap.

/work/miu/build -

Build directory, containing the master Make file (MakeAda), linker control files (.lcf), object files (.tof), main program executable (.xtof), and ECSPO executable for use on the SDF (.ESP).

/work/miu/cm -

This directory /work/miu/cm has the products of previous builds.

/work/miu/dlvr -

This directory contains the PROM burn files, the STE High Speed Load file and a few tools for transferring the PROM burn files to a DOS diskette.

/work/miu/list -

listing files created during compilation (.s, .ss), good for troubleshooting, patching.

/work/miu/rts -

Run Time System object module and source for modules which have been modified.

/work/miu/src -

Ada source code for the MIU application firmware.

/work/miu/test -

This is the directory where STE test results are stored.

/work/miu/lib -

The TARTAN Ada Library for the MIU Firmware.

/work/miu/proj -

The TARTAN Ada Project directory.

/work/miu/tools -

Unix based support tools are stored in the directory. Description of these tools are included elsewhere in this document.

*******************************************************************************

Refer to these documents for important information on:

-- How to set up a TARTAN project and library

Getting Started - Section 2.0
Compilation System Manual - Sections 2.0 & 3.0

-- Details regarding TARTAN Standard Packages

Compilation System Manual - Section 4.0
Compilation System Manual - Appendices A-K
(DO NOT USE functions from the package CHECKSUM)

-- Using the Linker/Explanation of Linker Control Files

Linker Manual

-- Runtime System Documentation

Compilation System Manual - Section 8.0
Runtime Modification Manual

(Remember, we're using the Static Expanded Memory RTS)

-- TARTAN Procedure Calling Protocol (good info on how to hook in assembler routines)

Compilation System Manual - Section 5.0

-- The TARTAN Assembler

-- The VAX Software Development Facility (SDF)

Intelsat-VIII PMDS User's Guide

********************************************************************************

Some Notes on Coding Approach and Standards

This is a real time, embedded system targeted for a computer with no console. External interfacing is handled by commands and telemetry. By design, commanding and telemetry functions are bundled into a single package for each. To protect the client packages from having global access to command and telemetry objects, intermediate packages called Uplink/Telemetry Data Packages (UTD) have been created. These are package specifications only, containing objects shared by the client package and Commanding/Telemetry functions.

Some rules must be obeyed for inclusion of UTD's, in order to avoid compilation and run time execution problems.

UTD's should be included in the Command/Telemetry package's body.

The client package body should include ONLY it's UTD. The UTD should NOT be included by the client package specification.

UTD's should generally avoid including the client package. In general, UTD's should include no other package except those that contain desired derived types.

Compilation order is always:

- Package Specification
- UTD
- Package Body
- Separates

And, a special case for Telemetry:

Because the telemetry schedules exist in it's UTD, it should be the last UTD compiled.

********************************************************************************

```
Memory Layout
                ROM                      RAM                       Function
Physical                   Physical             Logical
Address                    Address              Address
    0000 +---------+        00000 +---------+ 0000 I&O          BOOTSTRAP
    1000 |---------|        01000 |---------| 1000 I&O          APPL CODE & DATA
    2000 |---------|        02000 |---------| 2000 I            APPL CODE
    3000 |---------|        03000 |---------| 3000 I            APPL CODE
    4000 |---------|        04000 |---------| 4000 N            APPL CODE
    5000 |---------|        05000 |---------| 5000 N            APPL CODE
    6000 |---------|        06000 |---------| 6000 N            APPL CODE
    7000 |---------|        07000 |---------| 7000 N            APPL CODE
    8000 |---------|        08000 |---------| 8000 N            APPL CODE
    9000 |---------|        09000 |---------| 9000 N            APPL CODE
    A000 |---------|        0A000 |---------| A000 N            APPL CODE
    B000 |---------|        0B000 |---------| B000 N            APPL CODE
    C000 |---------|        0C000 |---------| C000 N            APPL CODE
    D000 |---------|        0D000 |---------| D000 O            APPL CONSTANTS
    E000 |---------|        0E000 |---------| E000 N            APPL CONSTANTS
    F000 |---------|        0F000 |---------| F000 O            APPL Linkage & Service Area
    FFFF +---------+        10000 |---------| 2000 O            APPL DATA
                            11000 |---------| 3000 O            APPL DATA
```

```
12000 |---------| 4000 O      APPL DATA
13000 |---------| 5000 N      APPL DATA
14000 |---------| 6000 N      APPL DATA
15000 |---------| 7000 N      APPL DATA
16000 |---------| 8000 N      APPL DATA
17000 |---------| 9000 N      APPL DATA
18000 |---------| 0000 N      No Access
19000 |---------| 0000 N      No Access
1A000 |---------| 0000 N      No Access
1B000 |---------| 0000 N      No Access
1C000 |---------| 0000 N      No Access
1D000 |---------| D000 N      APPL CODE
1E000 |---------| E000 N      APPL CODE
1F000 |---------| F000 N      APPL CODE
20000 |---------| A000 O      BCRTM SHARED
21000 |---------| B000 O      BCRTM SHARED
22000 |---------| 0000 N      No Access
23000 |---------| 0000 N      No Access
24000 |---------| 0000 N      No Access
25000 |---------| 0000 N      No Access
26000 |---------| 0000 N      No Access
27000 |---------| 0000 N      No Access
28000 |---------| C000 O      BCRTM REGISTERS
28011 +---------+ C000 O
```

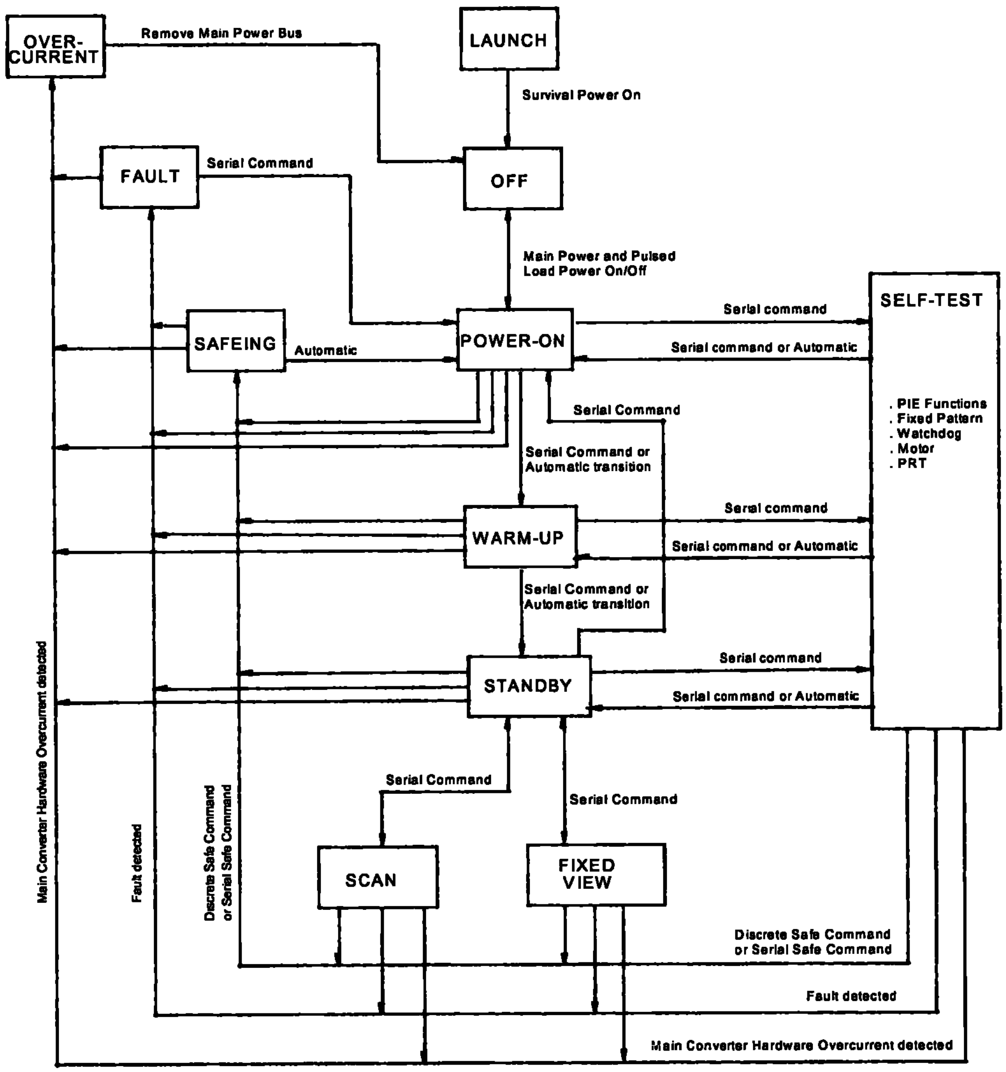
# 8. APPENDIX C MIU & MHS POWER UP SEQUENCES

The MHS power up sequence is preceded by the MIU power up and checkout. After the MIU checkout, power is applied to the MHS power interfaces. The physical application of power to the MHS results in the instrument transitioning to Power On mode. After the successful transition to Power On mode, the MHS instrument is commanded to turn on its SCE/SPE (Scan Control Electronics/Signal Processing Electronics). Before proceeding further, the loading of various MHS internal parameters must complete. The internal parameter load overwrites certain default values/limits resident in the MHS software. This is required because of the uniqueness of each MHS instrument. The TIROS program utilizes the Protoflight Model(PFM) on NOAA-N and the Flight Model 2(FM2) on the NOAA-N prime spacecraft.

The required tables loads for the PFM instrument are defined in JA215 Table 7.14.4 and Table 7.15.4 for the FM2 instrument. After the table loads are complete, the instrument can then be commanded to the other higher-level modes of operation. The 'as implemented' table loads are provided in Appendix E of this document.

A Mode transition diagram is provided in Figure 4.1-1 of the MHS 'JA215' document. **Anyone involved in MHS commanding should have a working knowledge of this diagram since not all mode transitions are allowed (such as Warm-Up to Power-On).** A copy of the mode transition diagram is presented below.

# MHS MODE TRANSITION DIAGRAM




ITAR CONTROLLED DATA

| Size | Code Ident No. | |
|---|---|---|
| A | 06887 | 8590724 |
| | | Sheet 87 |

## 8.1. MIU Turn-On

The MIU is turned on in the following sequence:

| # | CMD | FUNCTION | VERIFICATION |
|---|---|---|---|
| 1 | ..XMB MIUON N# Y | Enable Power to the MIU | DIGB 119 == ON (0);<br>A16A113==between 9.6&10.4 V;<br>A16A121==between 5.1 & 5.4 V |
| 2 | ..XMB MIURS N#Y | Resets the MIU | |
| 3 | ..XM U MI_BSTRP N # READY" | Commands the MIU into Boot Mode | |
| 4 | ..XM U MI_BSTRP N # MEM_LOAD D97A 0003 8004 8024 8044 | Upload words 1-3 of MIU Patch. This is to correct the packet duplication problem. | Verified by the memory dump of step 9 below. |
| 5 | ..XM U MI_BSTRP N # MEM_LOAD D97D 0003 819F 843F 86DF | Upload words 4-6 of MIU Patch. This is to correct the packet duplication problem. | Verified by the memory dump of step 9 below. |
| 6 | ..XM U MI_BSTRP N # MEM_LOAD D980 0003 8E7A 8E9A 8EBA | Upload words 7-9 of MIU Patch. This is to correct the packet duplication problem. | Verified by the memory dump of step 9 below. |
| 7 | ..XM U MI_BSTRP N # MEM_LOAD D983 0003 8EF2 8F72 8FF2 | Upload words 10-12 of MIU Patch. This is to correct the packet duplication problem. | Verified by the memory dump of step 9 below. |
| 8 | ..XM U MI_BSTRP N # MEM_LOAD D986 0003 9072 90F2 9172 | Upload words 13-15 of MIU Patch. This is to correct the packet duplication problem. | Verified by the memory dump of step 9 below. |
| 9 | ..XM U MI_BSTRP N # DUMP_RAM 0 28000" | Dump RAM to verify MIU S/W | Allow 300 seconds for DUMP and verify contents of patch locations. |
| 10 | ..XM U MI_BSTRP N # TRAN_CNRL 1000" | Transfer Control to MIU Flight Code | MIU 1 == 'NORMAL' |
| 11 | ..XM U MI_DSCON N # ENA_BUS_CNTRL | Enable the 1553 Bus controller | MIU 421 == 2(ON) |

### 8.2. MHS Turn-On

The MHS is turned on in the following sequence:

| # | NAGE CMD | FUNCTION | VERIFICATION |
|---|---|---|---|
| 1 | ..XM B MHMOE N # Y | Enables Main Bus Over current function. This cmd controls the voltage level on J103 pin 6 | DIGB190 == 1(Not Disabled) |
| 2 | ..XM B MHROE N # Y | Enables RF Converter Over current function. This cmd controls the voltage level on J103 pin 7. | DIGB166 == 1(Not Disabled) |
| 3 | ..XM B MHSHN N # Y | Enable Survival Heater Bus. This command will close the power relay supplying power to the MHS survival heaters. The heaters are further controlled by thermostats within the instrument. | DIGB126 == 1 (ON) |
| 4 | ..XM B MHSFB N # Y | Ensure that the 'B' side power relay is 'OFF'. This assumes that the MHS will be powered on the 'A' side. Reverse the 'A' and 'B' commanding if 'B' side will be powered. | DIGB 182 == 0(OFF) |
| 5 | ..XM B MHSNA N # Y | This will close the 'side A' power relay within the MIU. The application of power will result in the MHS turning on. Note that there are no power enabling relays within the MHS. Since power is applied to the 'A' side power feeds, than the MHS will turn-on on the PIE 'A' side. The PIE acronym refers to the MHS Processor Interface Electronics. | DIGB 187 == 1 (ON)<br><br>MHK 2 == 0(PIE A) |
| 6 | ..XM U MH_STM N # PWR_ON | This command will transition the MHS to 'Power On' mode. Note that the MHS will, in most cases, automatically go to 'Power On' mode after application of power (step 5 above). However, in some random population of turn-on events, the MHS will go to 'Fault' mode. This may occur because of the MHS S/W sampling some telemetry parameter at the instant of a turn-on transient that trigger a telemetry limit event. In the 'Fault' case, the Power On command is used to clear the fault. | MHK 1 == 0 (Pwr On)<br><br>MHS 1 == 0(Pwr On)<br><br>Note: the MHK identifier refers to telemetry data from the Housekeeping packet, while the MHS identifier refers to telemetry data from the Science packet. |

| | | | |
|---|---|---|---|
| 7 | ..XM U MH_SWC N # SS 4 1 | This command will turn on the SPE/SCE within the MHS. This command is one of the MHS 'Switch' commands. Refer to Appendix 10 for a full listing of these types of commands. This command must be executed before any further mode commands are executed. | MHK 36 == 1(ON) |
| 8 | ..XM U MH_STC N # NOW | This command will load the MHS internal clock with the current test time. This is the 'Set Time Code' command as described in section 4.2.1.8 of 'JA063'. The implementation on the TIROS NAGE is that the argument 'NOW' is used to load the current test time. | MHK 36 == 1(ON) |
| 9 | ..XM U MI_DSCON N # SEL_BUS_A | This command will select MIU 1553 Bus 'A' as the "Ground Preferred Bus". Although the ground made a selection, the MIU will automatically switch to the other bus upon a bus error. This bus command would be reserved for checkout & | MIU 121= Last Bus Used<br>MIU 122= Gnd Prefrd Bus<br>MIU 123= MIU Prefrd Bus<br>1 == (BUS-A) |
| 10 | ..XM U MI_DSCOF N # SEL_BUS_B | This command will select MIU 1553 Bus 'B' as the "Ground Preferred Bus". Although the ground made a selection, the MIU will automatically switch to the other bus upon a bus error. This bus command would be reserved for checkout & | MIU 121= Last Bus Used<br>MIU 122= Gnd Prefrd Bus<br>MIU 123= MIU Prefrd Bus<br>0 == (BUS-B) |
| 11P | ..XM U MH_LTD N # SCT 11 7D 6B 85 06 | This command will load the PFM PIE A Inductosyn offset parameter of 62.71 deg. The Scan control table contents are defined in Appendix C of the MHS '063' | Dump SCT and verify contents of address 0109C0 |
| 12P | ..XM U MH_LTD N # SCT 84 79 5A E1 08 | This command will load the PFM PIE B Inductosyn offset parameter to 242.71 deg. | Dump SCT and verify contents of address 0109C2 |
| 13P | ..XM U MH_LTD N # SCT 00 F4 F6 00 00 | This command will load the PFM RDM SDA max demand code | Dump SCT and verify contents of address 0109BA |
| 14P | ..XM U MH_LTD N # SCT 07 62 00 00 08 | This command will load the PFM RDM SDA amplifier gain to 196 | Dump SCT and verify contents of address 0109BE |
| 15P | ..XM U MH_LTD N # SCT 30 62 00 00 08 | This command will load the PFM FDM SDA amplifier gain to 196 | Dump SCT and verify contents of address 0109D0 |
| 16P | ..XM U MH_LTD N # TLT 87 2D 29 00 00 | This command will load the new limits for item 87 of the Telemetry Limits Table(TLT). See Appendix B of 'JA063'. | Dump TLT and verify contents of address 104E6 |
| 17P | ..XM U MH_LTD N # TLT 88 5D 3C 00 00 | This command will load the PFM RDM scan mode current limits. | Dump TLT and verify contents of address 104E8 |
| 18P | ..XM U MH_LTD N # TLT 90 2D 29 00 00 | This command will load the PFM FDM warm-up mode current limits. | Dump TLT and verify contents of address 104EC |
| 19P | ..XM U MH_LTD N # TLT 91 5D 3C 00 00 | This command will load the PFM FDM scan mode current limits. | Dump TLT and verify contents of address 104EE |

| | | | |
|---|---|---|---|
| 20P | ..XM U MH_LTD N # TLT 92 47 41 1E 17 | This command will load the PFM 5V supply Power-on mode current limits | Dump TLT and verify contents of address 104F0 |
| 21P | ..XM U MH_LTD N # DOT 00 3F 5E 46 27 | This command will load the DC offset values for MHS channel 1 thru 4. See Appendix D of 'JA063' for further details. | Dump DOT and verify contents of address 10810 - 10813 |
| 22P | ..XM U MH_LTD N # DOT 1 57 82 73 2C | This command will load the DC offset values for MHS channel 5 & SPE gain of 6.5. See Appendix D of 'JA063' for further details. | Dump DOT and verify contents of address 10814 |
| 23P | ..XM U MH_LTD N # SCT 01 0F 3C 3C 00 | This command will load the Earth Scan position error tolerance to 0.15 deg. | Dump SCT and verify contents of address 108D0 |
| 24P | ..XM U MH_LTD N # DOT 03 E6 58 7F F8 | This command will load the SPE dynamic range to 50%. | Dump DOT and verify contents of address 107E4 |
| 25P | ..XM U MH_LTD N # ICT 01 99 9A 9A 49 | This command will load the default Local Oscillator configuration for channels 1-4. See Appendix A of 'JA063'. | Dump ICT and verify contents of address 14FE1 & 14FE2. |
| 26P | ..XM U MH_LTD N # ICT 03 FF 80 00 00 | This command will load the default Local Oscillator configuration for channels 1-4. See Appendix A of 'JA063'. | Dump ICT and verify contents of address 14FE5 |
| 27 | ..XM U MH_STM N # WRM_UP | This command will place the instrument into Warm-Up mode. **Please note that the above table loads must be completed before entering this mode.** | MHK 2 == 1 |
| 28 | ..XM U MH_STM N # STBY | This command will place the instrument into Standby mode. Please note that the MHS instrument must be in Warm-Up mode for several hours before entering Standby or Scan modes, especially in T/V testing. A minimum time of 2 hours has been established for the T/V tests. On orbit, the warm-up time may be extended. | MHK 2 == 2 |
| 29 | ..XM U MH_STM N # SCAN | This command will place the instrument into Scan mode. Please note that for any configuration changes, the instrument has to be commanded to Standby mode first. This is especially important for any changes to the status of channel state or LO use. | MHK 2 == 3 |
| | | | |
| 11F | ..XM U MH_LTD N # DOT 0 3F 55 56 4C | This command will load the DC offset values for MHS channel 1 thru 4. See Appendix D of 'JA063' for further details. | Dump the DOT table and verify contents of address 10810 - 10813 |
| 12F | ..XM U MH_LTD N # DOT 1 38 82 73 2C | This command will load the DC offset values for the MHS channel 5 and SPE gain of 6.5 | Dump the DOT table and verify contents of address 10814 & 107E6 |

| | | | |
|---|---|---|---|
| 13F | ..XM U MH_LTD N # DOT 03 E6 58 7F F8 | This command will set the SPE minimum gain to 50%. | Dump the DOT table and verify contents of address 107E3 & 107E4 |
| 14F | ..XM U MH_LTD N # SCT 11 4D 37 6D 08 | This command will set the FM2 PIE A Inductosyn offset to 154.433 deg. | Dump the SCT table and verify contents of address 109C0 |
| 15F | ..XM U MH_LTD N # SCT 84 53 9B B6 09 | This command will set the FM2 PIE B Inductosyn offset to 344.433 deg. | Dump thc SCT table and verify contents of address 109C0 |
| 16F | ..XM U MH_LTD N # SCT 1 0F 3C 3C 00 | This command will set the FM2 Earth Scan position error tolerance to 0.15 deg. | Dump the SCT table and verify contents of address 108D0 |
| 17F | ..XM U MH_LTD N # SCT 12 41 89 38 FA | This command will set the cogging term 1 amplitude to 0.008. | Dump the SCT table and verify contents of address 10899 |
| 18F | ..XM U MH_LTD N # SCT 13 60 00 00 05 | This command will set the cogging term 1 frequency to 24. | Dump the SCT table and verify contents of address 1089B |
| 19F | ..XM U MH_LTD N # SCT 14 50 00 00 09 | This command will set the cogging term 1 phase to 320. | Dump the SCT table and verify contents of address 1089D |
| 20F | ..XM U MH_LTD N # SCT 90 5A 1C AC FA | This command will set the cogging term 2 amplitude to 0.011. | Dump the SCT table and verify contents of address 108D7 |
| 21F | ..XM U MH_LTD N # SCT 91 60 00 00 04 | This command will set the cogging term 2 frequency to 12. | Dump the SCT table and verify contents of address 108DF |
| 22F | ..XM U MH_LTD N # SCT 92 78 00 00 08 | This command will set the cogging term 2 phase to 240. | Dump the SCT table and verify contents of address 108E7 |
| 23F | ..XM U MH_LTD N # SCT 0 EE F6 80 00 | This command will set the RDM & FDM SDA max demand codes. | Dump the SCT table and verify contents of address 109BA |
| 24F | ..XM U MH_LTD N # SCT 07 5F 00 00 08 | This command will set the RDM SDA gain to 190.0. | Dump the SCT table and verify contents of address 108BE |
| 25F | ..XM U MH_LTD N # SCT 30 62 00 00 08 | This command will set the FDM SDA gain to 196.0. | Dump the SCT table and verify contents of address 108D0 |
| 26F | ..XM U MH_LTD N # TLT 87 2D 29 00 00 | This command will set the RDM Warm-up current limits | Dump the TLT table and verify contents of address 104E6 |
| 27F | ..XM U MH_LTD N # TLT 88 5D 3C 00 00 | This command will set the RDM scan mode current limits. | Dump the TLT table and verify contents of address 104E8 |
| 28F | ..XM U MH_LTD N # TLT 90 2D 29 00 00 | This command will set the FDM Warm-up mode current limits. | Dump the TLT table and verify contents of address 104E6 |

| | | | |
|---|---|---|---|
| 29F | ..XM U MH_LTD N # TLT 91 5D 3C 00 00 | This command will set the FDM scan mode current limits. | Dump the TLT table and verify contents of address 104EE |
| 30F | ..XM U MH_LTD N # TLT 92 47 41 1E 17 | This command will set the 5V converter Power-on mode current limits | Dump the TLT table and verify contents of address 104F0 |
| 31F | ..XM U MH_LTD N # ICT 01 99 9A 9A 49 | This command will load the default Local Oscillator configuration for channels 1-4. See Appendix A of 'JA063'. | Dump ICT and verify contents of address 14FE1 & 14FE2. |
| 32F | ..XM U MH_LTD N # ICT 03 FF 80 00 00 | This command will load the default Local Oscillator configuration for channels 1-4. See Appendix A of 'JA063'. | Dump ICT and verify contents of address 14FE5 |

In the above table, the item number with a 'P' suffix indicates that it applies only to the Protoflight Model MHS (PFM). Any item with 'F" suffix applies only to the Flight Model 2 MHS (FM2). For ease of reading, the PFM and FM2 specific loads are identified with grayscale background in the item number column. Also, the items shown in grayscale background of the entire row, are additions to the entries identified in sections 7.14 and 7.15 of the 'JA215' MHS document, suggesting that the 'JA215' document should be updated to show the 'as implemented' table loads.

## 9. APPENDIX D MHS COMMAND LISTS

This section presents MHS commands as implemented on the TIROS ATNAGE. It presents a basic 'User's Guide' for MHS commanding. Further information can be obtained in the TIROS command database as well in the MHS document MHS-TN-JA063-MMP.

As presented in section 5.1 of this document, the MHS instrument has 8 basic types of mode commands. These command types will be presented here as they are implemented in the NAGE system.

### 9.1. MHS SET MODE COMMANDS

| | | | |
|---|---|---|---|
| 1 | **..XM U MH_STM N 1 SAFE** | MHS Safe Mode Cmd | |
| 2 | **..XM U MH_STM N 1 PWR_ON** | MHS Power On Mode Cmd | |
| 3 | **..XM U MH_STM N 1 WRM_UP** | MHS Warm up Mode Cmd | |
| 4 | **..XM U MH_STM N 1 STBY** | MHS Standby Mode Cmd | |
| 5 | **..XM U MH_STM N 1 SCAN** | MHS Scan Mode Cmd | |
| 6 | **..XM U MH_STM N 1 F_VIEW** | MHS Fixed View Mode Cmd | |
| 7a | **..XM U MH_STM N 1 S_TEST Y PIE_FUNC** | MHS PIE Functional Self-Test Cmd. The 'Y' after the 'S_TEST' keyword enable the 'repeat' function of the self test | This command must be used in conjunction with the Load Table Data (ICT) command, which will set the types of self-tests to do. |
| 7b | **..XM U MH_STM N 1 S_TEST Y FIX_PAT** | MHS PIE Fixed Pattern Self Test Cmd | The 'default pattern is HEX(55) |
| 7c | **..XM U MH_ STM N 1 S_TEST Y MOTOR** | MHS PIE Motor Self Test Cmd | This cmd must be used in conjunction with the Load Table Data (ICT) cmd, which will set the types of self-tests to do. |

## 9.2. MHS READ TELEMETRY COMMANDS

| | | | |
|---|---|---|---|
| 1 | **..XM U MH_RTM N 1 2 3**<br><br>**The '2' above refers to the telemetry 'type' (1 thru 6)**<br><br>**The '3' above refers to the telemetry channel_#** | This command will read a telemetry channel and place in a location to be read out by Read Memory Data command. | This command is a diagnostic feature of limited use in spacecraft tests or flight. The reader is referred to the MHS 'JA215' document |

## 9.3. MHS SET FIXED VIEW POSITION COMMANDS

| | | | |
|---|---|---|---|
| 1 | **..XM U MH_FVP N 1 180** | MHS Fixed View Position. The '180' term is the position of 'Nadir'. Note that this command only sets the value for 'Fixed' Pointing. The MHS mode command 'Fixed View' is used to actually point the instrument. | Replace the '180' with '0' for internal Warm Target position. The '180' is an argument in 'degrees'. This could also to a floating pointing number, such as '5.50' degrees. |

## 9.4. MHS FIXED VIEW STEP COMMANDS

| | | | |
|---|---|---|---|
| 1 | **..XM U MH_FVS N 1 -14.11** | MHS Fixed View Step command. This command will move the scanner a relative angular distance from the present position. In this example, the scanner is moved a negative 14.11 degrees. | |

## 9.5. MHS LOAD MEMORY COMMANDS

| | | | |
|---|---|---|---|
| 1 | **..XM U MH_LDM N 1 013004 0000 0000 0000 0000** | This command will load four words of data starting at the address identified( in this case 013004 , which corresponds to the SCT table ; index 3. | |

## 9.6. MHS SET TIME CODE COMMAND

| | | | |
|---|---|---|---|
| 1 | **..XM U MH_STC N # NOW** | This command sets the MHS internal time as included in the header of each telemetry packet(MHK & MHS) | Presets MHS time word to the current time, as obtained from the NAGE time generator. |

## 9.7. MHS LOAD TABLE DATA COMMANDS

| | | | |
|---|---|---|---|
| 1 | **..XM U MH_LTD N 1 ICT 02 20 00 00 00** | This command loads four bytes of data into a data area identified by the 'type' of table (ICT,SCT,TLT,DOT). The first argument after the table 'type' is the index into the table as defined in the 'JA063' document and subsequent tables. After the table 'index', are the four data bytes. | |

## 9.8. MHS REQUEST MEMORY DATA PACKET COMMAND

The implementation of the MHS Request Memory Data Packet command is as described below. The implementation of this command as a sequence is required because of the use, by MHS, of the same 'op code'(39Hex) for either the 'Request Memory Data Packet' or 'Request Extended Memory Data Packet' commands. To implement the MHS 'op code' selection, the MIU is explicitly told to send a packet to either the 'Science' or 'C&T' RT.

| | | | |
|---|---|---|---|
| 1 | **..XM U MI_SULOD N # HK_MEM_CNT 4**<br><br>**-The 'SULOD' cmd is a MIU Type 3 command with an Opcode of 3001 for the HK_MEM_CNT function.**<br><br>**..XM U MI_EULOD N # HK_D_ADDR 010810**<br><br>**-The 'EULOD' cmd is a MIU Type 4 command with an Opcode of 4004 for the HK_D_ADDR function.**<br><br>**..XM U MI_ACTN N # SET_CNTL_MD 1**<br><br>**-The 'MI_ACTN' cmd is a MIU Type 9 command with an Opcode of 9009(Bus Controller Mode) for the SET_CNTL_MD function. The mode argument of '1' is for a HK Dump.** | This command sequence requests that the next HK packet replace its data with the contents of four memory locations starting with the 'start address'. | Ref. Section 4.2.1.10 of the 'JA-063' MHS document. |

## 9.9. MHS REQUEST EXTENDED MEMORY DATA PACKET COMMAND

The implementation of the MHS Request Extended Memory Data Packet command is as described below. The implementation of this command as a sequence is required because of the use, by MHS, of the same 'op code'(39Hex) for either the 'Request Memory Data Packet' or 'Request Extended Memory Data Packet' commands. To implement the MHS 'op code' selection, the MIU is explicitly told to send a packet to either the 'Science' or 'C&T' RT.

| | | | |
|---|---|---|---|
| 1 | **..XM U MI_SULOD N # SC_MEM_CNT 512**<br><br>**-The 'SULOD' cmd is a MIU Type 3 command with an Opcode of 3002 for the SC_MEM_CNT function.**<br><br>**..XM U MI_EULOD N # SC_D_ADDR 010810**<br><br>**-The 'EULOD' cmd is a MIU Type 4 command with an Opcode of 4005 for the SC_D_ADDR function.**<br><br>**..XM U MI_ACTN N # SET_CNTL_MD 2**<br><br>**-The 'MI_ACTN' cmd is a MIU Type 9 command with an Opcode of 9009(Bus Controller Mode) for the SET_CNTL_MD function. The mode argument of '2' is for a Science Dump.** | This command requests that the next SCIENCE packet replace its data with the contents of 512 memory locations starting with the 'start address'. In this example, the address is the start of the Telemetry Limits Table (TLT). | Ref. Section 4.3.1.2 of the 'JA-063' MHS document. |

MHS SWITCH COMMANDS

## (High Level Cmds [HL])

**NOTE: the CMD # refers to the JA-063 document Figure 6.1-1**

| CMD # | CMD DESCRIPTION | NAGE COMMAND |
|---|---|---|
| 1:01 | CHANNEL 1 ON | ..XM U MH_SWC N # HL 1 1 |
| 1:02 | CHANNEL 1 OFF | ..XM U MH_SWC N # HL 2 1 |
| 1:03 | CHANNEL 1 SELECT LO A | ..XM U MH_SWC N # HL 3 1 |
| 1:04 | CHANNEL 1 SELECT LO B | ..XM U MH_SWC N # HL 4 1 |
| 1:05 | CHANNEL 2 ON | ..XM U MH_SWC N # HL 5 1 |
| 1:06 | CHANNEL 2 OFF | ..XM U MH_SWC N # HL 6 1 |
| 1:07 | CHANNEL 2 SELECT LO A | ..XM U MH_SWC N # HL 7 1 |
| 1:08 | CHANNEL 2 SELECT LO B | ..XM U MH_SWC N # HL 8 1 |
| 1:09 | CHANNELS 3/4 FRONTEND ON | ..XM U MH_SWC N # HL 9 1 |
| 1:10 | CHANNELS 3/4 FRONTEND OFF | ..XM U MH_SWC N # HL 10 1 |
| 1:11 | CHANNELS 3/4 SELECT LO A | ..XM U MH_SWC N # HL 11 1 |
| 1:12 | CHANNELS 3/4 SELECT LO B | ..XM U MH_SWC N # HL 12 1 |
| 1:13 | CHANNEL 3 BACKEND ON | ..XM U MH_SWC N # HL 13 1 |
| 1:14 | CHANNEL 3 BACKEND OFF | ..XM U MH_SWC N # HL 14 1 |
| 1:15 | CHANNEL 4 BACKEND ON | ..XM U MH_SWC N # HL 15 1 |
| 1:16 | CHANNEL 4 BACKEND OFF | ..XM U MH_SWC N # HL 16 1 |
| 1:17 | CHANNEL 5 ON | ..XM U MH_SWC N # HL 17 1 |
| 1:18 | CHANNEL 5 OFF | ..XM U MH_SWC N # HL 18 1 |
| 1:19 | CHANNEL 5 SELECT LO A | ..XM U MH_SWC N # HL 19 1 |
| 1:20 | CHANNEL 5 SELECT LO B | ..XM U MH_SWC N # HL 20 1 |
| 1:21 | RFCV ON | ..XM U MH_SWC N # HL 21 1 |
| 1:22 | RFCV OFF | ..XM U MH_SWC N # HL 22 1 |
| 1:23 | CHANNEL 1 GAIN RESET | ..XM U MH_SWC N # HL 23 1 |
| 1:24 | CHANNEL 1 GAIN 1 dB | ..XM U MH_SWC N # HL 24 1 |
| 1:25 | CHANNEL 1 GAIN 2 dB | ..XM U MH_SWC N # HL 25 1 |
| 1:26 | CHANNEL 2 GAIN RESET | ..XM U MH_SWC N # HL 26 1 |
| 1:27 | CHANNEL 2 GAIN 1 dB | ..XM U MH_SWC N # HL 27 1 |
| 1:28 | CHANNEL 2 GAIN 2 dB | ..XM U MH_SWC N # HL 28 1 |
| 1:29 | CHANNEL 3 GAIN RESET | ..XM U MH_SWC N # HL 29 1 |
| 1:30 | CHANNEL 3 GAIN 1 dB | ..XM U MH_SWC N # HL 30 1 |
| 1:31 | CHANNEL 3 GAIN 2 dB | ..XM U MH_SWC N # HL 31 1 |
| 1:32 | CHANNEL 4 GAIN RESET | ..XM U MH_SWC N # HL 32 1 |
| 1:33 | CHANNEL 4 GAIN 1 dB | ..XM U MH_SWC N # HL 33 1 |
| 1:34 | CHANNEL 4 GAIN 2 dB | ..XM U MH_SWC N # HL 34 1 |
| 1:35 | CHANNEL 5 GAIN RESET | ..XM U MH_SWC N # HL 35 1 |
| 1:36 | CHANNEL 5 GAIN 1 dB | ..XM U MH_SWC N # HL 36 1 |
| 1:37 | CHANNEL 5 GAIN 2 dB | ..XM U MH_SWC N # HL 37 1 |

## 9.10. MHS SWITCH COMMANDS

**(Steady State Cmds [SS])**

**NOTE: the CMD # refers to the JA-063 document Figure 6.2-1**

| CMD # | CMD DESCRIPTION | NAGE COMMAND |
|---|---|---|
| 2:01 | Receiver Operational Htrs ON | ..XM U MH_SWC N # SS 1 1 |
| 2:01 | Receiver Operational Htrs OFF | ..XM U MH_SWC N # SS 1 0 |
| 2:02 | SM Operational Htrs ON | ..XM U MH_SWC N # SS 2 1 |
| 2:02 | SM Operational Htrs OFF | ..XM U MH_SWC N # SS 2 0 |
| 2:03 | Aux Operational Htrs ON | ..XM U MH_SWC N # SS 3 1 |
| 2:03 | Aux Operational Htrs OFF | ..XM U MH_SWC N # SS 3 0 |
| 2:04 | SPE/SCE ON | ..XM U MH_SWC N # SS 4 1 |
| 2:04 | SPE/SCE OFF | ..XM U MH_SWC N # SS 4 0 |

## 9.11. Inter-Module Bus Cmds [BIM]

**NOTE: the CMD # refers to the JA-063 document Figure 6.3-1**

| CMD # | CMD DESCRIPTION | NAGE COMMAND |
|---|---|---|
| 3:01 | SPE Mux Code MSB = 0 | ..XM U MH_SWC N # BIM 1 0 |
| 3:01 | SPE Mux Code MSB = 1 | ..XM U MH_SWC N # BIM 1 1 |
| 3:02 | SPE Mux Code MID = 0 | ..XM U MH_SWC N # BIM 2 0 |
| 3:02 | SPE Mux Code MID = 1 | ..XM U MH_SWC N # BIM 2 1 |
| 3:03 | SPE Mux Code LSB = 0 | ..XM U MH_SWC N # BIM 3 0 |
| 3:03 | SPE Mux Code LSB = 1 | ..XM U MH_SWC N # BIM 3 1 |
| 3:04 | Select RDM Zero Pos Sensor A | ..XM U MH_SWC N # BIM 4 0 |
| 3:04 | Select RDM Zero Pos Sensor B | ..XM U MH_SWC N # BIM 4 1 |
| 3:05 | Select FDM Zero Pos Sensor A | ..XM U MH_SWC N # BIM 5 0 |
| 3:05 | Select FDM Zero Pos Sensor B | ..XM U MH_SWC N # BIM 5 1 |
| 3:06 | Select RDM Motor Sensor A | ..XM U MH_SWC N # BIM 6 0 |
| 3:06 | Select RDM Motor Sensor B | ..XM U MH_SWC N # BIM 6 1 |
| 3:07 | Select FDM Motor Sensor A | ..XM U MH_SWC N # BIM 7 0 |
| 3:07 | Select FDM Motor Sensor B | ..XM U MH_SWC N # BIM 7 1 |
| 3:08 | RDM Motor Supply OFF | ..XM U MH_SWC N # BIM 8 0 |
| 3:08 | RDM Motor Supply ON | ..XM U MH_SWC N # BIM 8 1 |
| 3:09 | FDM Motor Supply OFF | ..XM U MH_SWC N # BIM 9 0 |
| 3:09 | FDM Motor Supply ON | ..XM U MH_SWC N # BIM 9 1 |
| 3:10 | RDM Motor Current Trip ENABLE | ..XM U MH_SWC N # BIM 10 0 |
| 3:10 | RDM Motor Current Trip DISABLE | ..XM U MH_SWC N # BIM 10 1 |
| 3:11 | FDM Motor Current Trip ENABLE | ..XM U MH_SWC N # BIM 11 0 |
| 3:11 | FDM Motor Current Trip DISABLE | ..XM U MH_SWC N # BIM 11 1 |

## 10. APPENDIX E MHS LOAD TABLES

This section attempts to summarize the contents of the internal MHS tables, which are used for the operation of the MHS instrument. These tables are modified during the MHS power up sequences. The items that are modified during the power up table loads are indicated by using colors to highlight the affected entries.

### 10.1. MHS Instrument Configuration Table (ICT) – See Appendix A of 'JA063'

| ICT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 0 | Control (Auto/Manual) | 00 00 00 E0 | PROM DEFAULT | PROM DEFAULT | 14FDF |
| 1 | HL Commands(1-4) | AA AA AA 49 | 99 9A 9A 49 | 99 9A 9A 49 | 14FE1 |
| 2 | HL Commands(5) & heater control | 20 00 00 00 | 60 00 00 00 in 'JA215' but not implemented | PROM DEFAULT | 14FE3 |
| 3 | BIM Commands | E1 80 00 00 | FF 80 00 00 | FF 80 00 00 | 14FE5 |
| 4 | PIE Test Enables | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 14FE7 |
| 5 | Memory Self Test | 00 00 00 01 | PROM DEFAULT | PROM DEFAULT | 14FE9 |
| 6 | Memory Self Test | FF FF AA AA | PROM DEFAULT | PROM DEFAULT | 14FEB |
| 7 | Memory Self Test & Self test pattern | 00 01 55 00 | PROM DEFAULT | PROM DEFAULT | 14FED |
| 8 | Motor Test | F0 00 00 0C | PROM DEFAULT | PROM DEFAULT | 14FEF |

## 10.2. MHS Telemetry Limit Table (TLT) – See Appendix B of 'JA063'

| TLT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 0 | UNUSED | N/A | N/A | N/A | |
| 1 | LO H1 TEMP LIMITS (PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10500 |
| 2 | LO H2 TEMP LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10502 |
| 3 | LO H3/4 TEMP LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10504 |
| 4 | LO H5 TEMP LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10506 |
| 5 | MIX/MUX H1 temp LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10508 |
| 6 | MIX/MUX H2 temp LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 1050A |
| 7 | MIX/MUX H3/4 temp LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 1050C |
| 8 | MIX/MUX H5 temp LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 1050E |
| 9 | QO BSPT TEMP 1 LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10510 |
| 10 | QO BSPT TEMP 2 LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10512 |
| 11 | IF BSPT TEMP 1 LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10514 |
| 12 | IF BSPT TEMP 2 LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10516 |

| TLT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 13 | SM CORE TEMP LIMITS(PWR ON) | FE FD 55 4B | PROM DEFAULT | PROM DEFAULT | 10518 |
| 14 | SM HSG TEMP LIMITS(PWR ON) | FE FD 55 4B | PROM DEFAULT | PROM DEFAULT | 1051A |
| 15 | RDM SSHM TEMP LIMITS(PWR ON) | FE FD 55 4B | PROM DEFAULT | PROM DEFAULT | 1051C |
| 16 | FDM SSHM TEMP LIMITS(PWR ON) | FE FD 55 4B | PROM DEFAULT | PROM DEFAULT | 1051E |
| 17 | STRUCT 1 TEMP LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10520 |
| 18 | STRUCT 2 TEMP LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10522 |
| 19 | STRUCT 3 TEMP LIMITS(PWR ON) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10524 |
| 20 | Processor Temp LIMITS(PWR ON) | F6 EC 33 28 | PROM DEFAULT | PROM DEFAULT | 10526 |
| 21 | Main DC/DC Temp LIMITS(PWR ON) | F6 EC 30 25 | PROM DEFAULT | PROM DEFAULT | 10528 |
| 22 | SCE RDM Temp LIMITS(PWR ON) | F6 EC 31 26 | PROM DEFAULT | PROM DEFAULT | 1052A |
| 23 | SCE FDM Temp LIMITS(PWR ON) | F6 EC 31 26 | PROM DEFAULT | PROM DEFAULT | 1052C |
| 24 | RF DC/DC Temp LIMITS(PWR ON) | F6 EC 3E 30 | PROM DEFAULT | PROM DEFAULT | 1052E |
| 25 | LO H1 TEMP LIMITS (WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10530 |
| 26 | LO H2 TEMP LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10532 |

| TLT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 27 | LO H3/4 TEMP LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10534 |
| 28 | LO H5 TEMP LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10536 |
| 29 | MIX/MUX H1 temp LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10538 |
| 30 | MIX/MUX H2 temp LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 1053A |
| 31 | MIX/MUX H3/4 temp LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 1053C |
| 32 | MIX/MUX H5 temp LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 1053E |
| 33 | QO BSPT TEMP 1 LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10540 |
| 34 | QO BSPT TEMP 2 LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10542 |
| 35 | IF BSPT TEMP 1 LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10544 |
| 36 | IF BSPT TEMP 2 LIMITS(WARM UP) | F6 EC 55 4B | PROM DEFAULT | PROM DEFAULT | 10546 |
| 37 | SM CORE TEMP LIMITS(WARM UP) | FE FD 55 4B | PROM DEFAULT | PROM DEFAULT | 10548 |
| 38 | SM HSG TEMP LIMITS(WARM UP) | FE FD 55 4B | PROM DEFAULT | PROM DEFAULT | 1054A |
| 39 | RDM SSHM TEMP LIMITS(WARM UP) | FE FD 55 4B | PROM DEFAULT | PROM DEFAULT | 1054C |
| 40 | FDM SSHM TEMP LIMITS(WARM UP) | FE FD 55 4B | PROM DEFAULT | PROM DEFAULT | 1054E |

| TLT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 41 | STRUCT 1 TEMP LIMITS(WARM UP) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10550 |
| 42 | STRUCT 2 TEMP LIMITS(WARM UP) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10552 |
| 43 | STRUCT 3 TEMP LIMITS(WARM UP) | FE FD 42 3A | PROM DEFAULT | PROM DEFAULT | 10554 |
| 44 | Processor Temp LIMITS(WARM UP) | F6 EC 33 28 | PROM DEFAULT | PROM DEFAULT | 10556 |
| 45 | Main DC/DC Temp LIMITS(WARM UP) | F6 EC 30 25 | PROM DEFAULT | PROM DEFAULT | 10558 |
| 46 | SCE RDM Temp LIMITS(WARM UP) | F6 EC 31 26 | PROM DEFAULT | PROM DEFAULT | 1055A |
| 47 | SCE FDM Temp LIMITS(WARM UP) | F6 EC 31 26 | PROM DEFAULT | PROM DEFAULT | 1055C |
| 48 | RF DC/DC Temp LIMITS(WARM UP) | F6 EC 3E 30 | PROM DEFAULT | PROM DEFAULT | 1055E |
| 49 | LO H1 TEMP LIMITS (SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10560 |
| 50 | LO H2 TEMP LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10562 |
| 51 | LO H3/4 TEMP LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10564 |
| 52 | LO H5 TEMP LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10566 |
| 53 | MIX/MUX H1 temp LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10568 |
| 54 | MIX/MUX H2 temp LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 1056A |

| TLT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 55 | MIX/MUX H3/4 temp LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 1056C |
| 56 | MIX/MUX H5 temp LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 1056E |
| 57 | QO BSPT TEMP 1 LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10570 |
| 58 | QO BSPT TEMP 2 LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10572 |
| 59 | IF BSPT TEMP 1 LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10574 |
| 60 | IF BSPT TEMP 2 LIMITS(SCAN) | AD A1 6C 60 | PROM DEFAULT | PROM DEFAULT | 10576 |
| 61 | SM CORE TEMP LIMITS(SCAN) | DF D3 55 4B | PROM DEFAULT | PROM DEFAULT | 10578 |
| 62 | SM HSG TEMP LIMITS(SCAN) | DF D3 55 4B | PROM DEFAULT | PROM DEFAULT | 1057A |
| 63 | RDM SSHM TEMP LIMITS(SCAN) | DF D3 55 4B | PROM DEFAULT | PROM DEFAULT | 1057C |
| 64 | FDM SSHM TEMP LIMITS(SCAN) | DF D3 55 4B | PROM DEFAULT | PROM DEFAULT | 1057E |
| 65 | STRUCT 1 TEMP LIMITS(SCAN) | FA F6 6C 60 | PROM DEFAULT | PROM DEFAULT | 10580 |
| 66 | STRUCT 2 TEMP LIMITS(SCAN) | FA F6 6C 60 | PROM DEFAULT | PROM DEFAULT | 10582 |
| 67 | STRUCT 3 TEMP LIMITS(SCAN) | FA F6 6C 60 | PROM DEFAULT | PROM DEFAULT | 10584 |
| 68 | Processor Temp LIMITS(SCAN) | E0 D3 33 28 | PROM DEFAULT | PROM DEFAULT | 10586 |

| TLT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 69 | Main DC/DC Temp LIMITS(SCAN) | E0 D3 30 25 | PROM DEFAULT | PROM DEFAULT | 10588 |
| 70 | SCE RDM Temp LIMITS(SCAN) | E0 D3 31 26 | PROM DEFAULT | PROM DEFAULT | 1058A |
| 71 | SCE FDM Temp LIMITS(SCAN) | E0 D3 31 26 | PROM DEFAULT | PROM DEFAULT | 1058C |
| 72 | RF DC/DC Temp LIMITS(SCAN) | E0 D3 3E 30 | PROM DEFAULT | PROM DEFAULT | 1058E |
| 73 | T1-4 (PWR-WRMUP) Transition Limits | EC EC EC EC | PROM DEFAULT | PROM DEFAULT | 10590 |
| 74 | T5-8 (PWR-WRMUP) Transition Limits | EC EC EC EC | PROM DEFAULT | PROM DEFAULT | 1059C |
| 75 | T9-12 (PWR-WRMUP) Transition Limits | EC EC EC EC | PROM DEFAULT | PROM DEFAULT | 105A8 |
| 76 | T13-16 (PWR-WRMUP) Transition Limits | FD FD FD FD | PROM DEFAULT | PROM DEFAULT | 105B4 |
| 77 | T17-20 (PWR-WRMUP) Transition Limits | FD FD FD EC | PROM DEFAULT | PROM DEFAULT | 105C0 |
| 78 | T21-24 (PWR-WRMUP) Transition Limits | EC EC EC EC | PROM DEFAULT | PROM DEFAULT | 105CC |
| 79 | T1-4 (WRMUP-STBY) Transition Limits | A0 A0 A0 A0 | PROM DEFAULT | PROM DEFAULT | 10591 |
| 80 | T5-8 (WRMUP-STBY) Transition Limits | A0 A0 A0 A0 | PROM DEFAULT | PROM DEFAULT | 1059D |

| TLT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 81 | T9-12 (WRMUP-STBY) Transition Limits | A0 A0 A0 A0 | PROM DEFAULT | PROM DEFAULT | 105A9 |
| 82 | T13-16 (WRMUP-STBY) Transition Limits | D3 D3 D3 D3 | PROM DEFAULT | PROM DEFAULT | 105B5 |
| 83 | T17-20 (WRMUP-STBY) Transition Limits | F6 F6 F6 D3 | PROM DEFAULT | PROM DEFAULT | 105C1 |
| 84 | T21-24 (WRMUP-STBY) Transition Limits | D3 D3 D3 D3 | PROM DEFAULT | PROM DEFAULT | 105CD |
| 85 | TIME FOR TRANSITION 1 & 2 | 00 78 00 78 | PROM DEFAULT | PROM DEFAULT | 10627 |
| 86 | RDM current limit (PWR ON) | 02 01 00 00 | PROM DEFAULT | PROM DEFAULT | 104E4 |
| 87 | RDM current limit (WARM UP) | 16 0E 00 00 | 2D 29 00 00 | 2D 29 00 00 | 104E6 |
| 88 | RDM current limit (SCAN) | 74 70 52 4D | 5D 3C 00 00 | 5D 3C 00 00 | 104E8 |
| 89 | FDM current limit (PWR ON) | 02 01 00 00 | PROM DEFAULT | PROM DEFAULT | 10EEA |
| 90 | FDM current limit (WARM UP) | 16 0E 00 00 | 2D 29 00 00 | 2D 29 00 00 | 104EC |
| 91 | FDM current limit (SCAN) | 74 70 52 4D | 5D 3C 00 00 | 5D 3C 00 00 | 104EE |
| 92 | EE1 current limit | 2E 2A 22 1E | 47 41 1E 17 | 47 41 1E 17 | 104F0 |
| 93 | EE2 current limits | 47 41 35 2F | PROM DEFAULT | PROM DEFAULT | 104F2 |

| TLT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 94 | RX8-OFF limits | 1B 10 00 00 | PROM DEFAULT | PROM DEFAULT | 104F4 |
| 95 | RX8 ON limits | 55 53 3E 00 | PROM DEFAULT | PROM DEFAULT | 104F6 |
| 96 | RXP15 OFF limits | 20 14 00 00 | PROM DEFAULT | PROM DEFAULT | 104F8 |
| 97 | RXP15 ON limits | 7B 73 5B 00 | PROM DEFAULT | PROM DEFAULT | 104FA |
| 98 | RXM15 OFF limits | 25 1A 00 00 | PROM DEFAULT | PROM DEFAULT | 104FC |
| 99 | RXM15 ON limits | 7F 67 4C 00 | PROM DEFAULT | PROM DEFAULT | 104FE |

## 11. APPENDIX F MHS TELEMETRY TABLES

The following four tables summarize the MHS instrument telemetry. Along with the NAGE identifier, the information in these tables attempts to point the reader at the source of the telemetry definition in the MHS document (MHS-TN-JA063-MMP). In addition, the NAGE page that displays the information is identified.

**TABLE 11.1 MHS Scan Control Table (SCT) – See Appendix C of 'JA063'**

| SCT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 0 | SDA Demand Code & Cog/Ripple comp. | F0 F3 80 00 | F4 F6 00 00 | EE F6 80 00 | 109BA, 109CC, 10861, 108CD, 10864 |
| 1 | Pos Error Tolerance | 0A 3C 00 | 0F 3C 00 | 0F 3C 00 | 108D0, 108CE, 10895 |
| 2 | Pos Measurement initial velocity | 0C 00 | PROM DEFAULT | PROM DEFAULT | 108AF |
| 3 | PROFILE | 00 | PROM DEFAULT | PROM DEFAULT | 13003 |
| 4 | RDM Mtr Mom of Inertia | 4B 87 BE FA | PROM DEFAULT | PROM DEFAULT | 108B7 |
| 5 | RDM Motor Constant | 72 4D D3 00 | PROM DEFAULT | PROM DEFAULT | 1089F |
| 6 | RDM Amp Offset | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 109BC |
| 7 | RDM Amp Gain | 60 94 7B 08 | 62 00 00 08 | 5F 00 00 08 | 109BE |
| 8 | RDM Inductosyn amplitude correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108A3 |
| 9 | RDM Inductosyn frequency correction | 64 00 00 06 | PROM DEFAULT | PROM DEFAULT | 108B3 |
| 10 | RDM Inductosyn phase correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108B5 |

| SCT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 11 | RDM Inductosyn zero pos correction | 00 00 00 00 | 7D 6B 85 06 | 4D 37 6D 08 | 109C0 |
| 12 | RDM cogging amplitude correction | 51 EB 85 FB | PROM DEFAULT | 41 89 38 FA | 10899 |
| 13 | RDM cogging frequency correction | 4E 00 00 08 | PROM DEFAULT | 60 00 00 05 | 1089B |
| 14 | RDM cogging phase correction | 00 00 00 00 | PROM DEFAULT | 50 00 00 09 | 1089D |
| 15 | RDM ripple torque amplitude correction | 77 5F 70 70 | PROM DEFAULT | PROM DEFAULT | 108BB |
| 16 | UNUSED | N/A | N/A | N/A | N/A |
| 17 | UNUSED | N/A | N/A | N/A | N/A |
| 18 | RDM ripple torque phase correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108BF |
| 19 | RDM scan proportional gain | 5D 6A 16 FF | PROM DEFAULT | PROM DEFAULT | 108B9 |
| 20 | RDM scan integral gain | 4B 9D B2 03 | PROM DEFAULT | PROM DEFAULT | 108B1 |
| 21 | RDM scan derivative gain | 6B B9 8C FA | PROM DEFAULT | PROM DEFAULT | 108A1 |
| 22 | RDM scan global gain | 40 00 00 01 | PROM DEFAULT | PROM DEFAULT | 108A5 |
| 23 | RDM FV prop gain | 77 65 FE FF | PROM DEFAULT | PROM DEFAULT | 108AD |
| 24 | UNUSED | N/A | N/A | N/A | N/A |
| 25 | RDM FV derivative gain | 6B B9 8C FA | PROM DEFAULT | PROM DEFAULT | 108A7 |
| 26 | RDM FV global gain | 6B B9 8C FA | PROM DEFAULT | PROM DEFAULT | 108A9 |

| SCT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 27 | FDM Mtr Mom of Inertia | 48 D3 AE FA | PROM DEFAULT | PROM DEFAULT | 10885 |
| 28 | FDM Motor Constant | 70 E5 60 00 | PROM DEFAULT | PROM DEFAULT | 1086F |
| 29 | FDM Amp Offset | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 109CE |
| 30 | FDM Amp Gain | 60 94 7B 08 | 62 00 00 08 | 62 00 00 08 | 109D0 |
| 31 | FDM Inductosyn amplitude correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 10873 |
| 32 | FDM Inductosyn frequency correction | 64 00 00 06 | PROM DEFAULT | PROM DEFAULT | 10881 |
| 33 | FDM Inductosyn phase correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 10883 |
| 34 | UNUSED | N/A | N/A | N/A | N/A |
| 35 | FDM cogging amplitude correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 10869 |
| 36 | FDM cogging frequency correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 1086B |
| 37 | FDM cogging phase correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 1086D |
| 38 | FDM ripple torque amplitude correction | 77 5F 70 70 | PROM DEFAULT | PROM DEFAULT | 10889 |
| 39 | UNUSED | N/A | N/A | N/A | N/A |
| 40 | UNUSED | N/A | N/A | N/A | N/A |
| 41 | FDM ripple torque phase correction | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 1088D |
| 42 | FDM scan proportional gain | 63 46 DC FF | PROM DEFAULT | PROM DEFAULT | 10887 |

| SCT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 43 | UNUSED | N/A | N/A | N/A | N/A |
| 44 | FDM Scan mode derivative gain | 4A 0E 41 FA | PROM DEFAULT | PROM DEFAULT | 10871 |
| 45 | FDM Scan mode global gain | 40 00 00 01 | PROM DEFAULT | PROM DEFAULT | 10875 |
| 46 | FDM FV prop gain | 73 1F 8A FF | PROM DEFAULT | PROM DEFAULT | 1087F |
| 47 | UNUSED | N/A | N/A | N/A | N/A |
| 48 | FDM FV derivative gain | 67 DF E3 FA | PROM DEFAULT | PROM DEFAULT | 10877 |
| 49 | FDM FV global gain | 40 00 00 01 | PROM DEFAULT | PROM DEFAULT | 10878 |
| 50 | Ratio of Inertia (RDM/FDM) | 40 00 00 01 | PROM DEFAULT | PROM DEFAULT | 10897 |
| 51 | Gamma1 (profile 0 acceleration 1) | 4A 79 9A 0D | PROM DEFAULT | PROM DEFAULT | 14F8D |
| 52 | Gamma2 (profile 0 acceleration 2) | 50 56 BA 0D | PROM DEFAULT | PROM DEFAULT | 14F8F |
| 53 | Gamma3 (profile 0 acceleration 3) | 4D 7E CC 0D | PROM DEFAULT | PROM DEFAULT | 14F91 |
| 54 | Scan Speed(profile 0 scan velocity) | 78 00 00 06 | PROM DEFAULT | PROM DEFAULT | 14F93 |
| 55 | C1&C2 (profile 0; phase 1&2) | 02 D0 02 E8 | PROM DEFAULT | PROM DEFAULT | 14F85 |
| 56 | C3&C4 (profile 0; phase 3&4) | 03 00 03 20 | PROM DEFAULT | PROM DEFAULT | 14F86 |
| 57 | C5&C6 (profile 0; phase 5&6) | 03 58 03 90 | PROM DEFAULT | PROM DEFAULT | 14F88 |

| SCT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 58 | C7&C8 (profile 0; phase 7&8) | 03 B0 03 ED | PROM DEFAULT | PROM DEFAULT | 14F8A |
| 59 | C9 (profile 0; phase 9) | 04 2A 00 00 | PROM DEFAULT | PROM DEFAULT | 14F8C |
| 60 | Gamma1 (profile 1 acceleration 1) | 52 F1 AA 0D | PROM DEFAULT | PROM DEFAULT | 14F9E |
| 61 | Gamma2 (profile 1 acceleration 2) | 48 AF 1B 0D | PROM DEFAULT | PROM DEFAULT | 14FA0 |
| 62 | Gamma3 (profile 1 acceleration 3) | 4D 7E CC 0D | PROM DEFAULT | PROM DEFAULT | 14FA2 |
| 63 | Scan Speed(profile 1 scan velocity) | 78 00 00 06 | PROM DEFAULT | PROM DEFAULT | 14FA4 |
| 64 | C1&C2 (profile 1; phase 1&2) | 02 D0 02 E4 | PROM DEFAULT | PROM DEFAULT | 14F95 |
| 65 | C3&C4 (profile 1; phase 3&4) | 02 F8 03 18 | PROM DEFAULT | PROM DEFAULT | 14F97 |
| 66 | C5&C6 (profile 1; phase 5&6) | 03 54 03 90 | PROM DEFAULT | PROM DEFAULT | 14F99 |
| 67 | C7&C8 (profile 1; phase 7&8) | 03 B0 03 ED | PROM DEFAULT | PROM DEFAULT | 14F9B |
| 68 | C9 (profile 1; phase 9) | 04 2A 00 00 | PROM DEFAULT | PROM DEFAULT | 14F9D |
| 69 | Gamma1 (profile 2 acceleration 1) | 43 1D 42 0D | PROM DEFAULT | PROM DEFAULT | 14FAF |
| 70 | Gamma2 (profile 2 acceleration 2) | 59 94 4C 0D | PROM DEFAULT | PROM DEFAULT | 14FB1 |
| 71 | Gamma3 (profile 2 acceleration 3) | 4D 7E CC 0D | PROM DEFAULT | PROM DEFAULT | 14FB3 |

| SCT Item | Description | PROM<br><br>Value<br><br>(hex) | PFM (after Loads)<br><br>(hex) | FM2 (after Loads)<br><br>(hex) | Address<br><br>(hex) |
|---|---|---|---|---|---|
| 72 | Scan Speed(profile 2 scan velocity) | 78 00 00 06 | PROM DEFAULT | PROM DEFAULT | 14FB5 |
| 73 | C1&C2 (profile 2; phase 1&2) | 02 D0 02 EC | PROM DEFAULT | PROM DEFAULT | 14FA6 |
| 74 | C3&C4 (profile 2; phase 3&4) | 03 08 03 28 | PROM DEFAULT | PROM DEFAULT | 14FA8 |
| 75 | C5&C6 (profile 2; phase 5&6) | 03 5C 03 90 | PROM DEFAULT | PROM DEFAULT | 14FAA |
| 76 | C7&C8 (profile 2; phase 7&8) | 03 B0 03 ED | PROM DEFAULT | PROM DEFAULT | 14FAC |
| 77 | C9 (profile 2; phase 9) | 04 2A 00 00 | PROM DEFAULT | PROM DEFAULT | 14FAE |
| 78 | Integration Start/Stop | 00 00 02 D0 | PROM DEFAULT | PROM DEFAULT | 108D2; 10866 |
| 79 | Epsilon_max ( FV limit torque error ) | 5A 39 58 02 | PROM DEFAULT | PROM DEFAULT | 10867 |
| 80 | RDM CV derivative gain | 6B B9 8C FA | PROM DEFAULT | PROM DEFAULT | 108C7 |
| 81 | RDM CV global gain | 40 00 00 01 | PROM DEFAULT | PROM DEFAULT | 108C9 |
| 82 | FDM CV derivative gain | 67 DF E3 FA | PROM DEFAULT | PROM DEFAULT | 1088F |
| 83 | FDM CV global gain | 40 00 00 01 | PROM DEFAULT | PROM DEFAULT | 10891 |
| 84 | RDM Inductosyn zero pos B offset | 5A 00 00 08 | 79 5A E1 08 | PROM DEFAULT | 109C2 |
| 85 | RDM CV proportional term | 77 65 FE FF | PROM DEFAULT | PROM DEFAULT | 108CB |

| SCT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 86 | FDM CV proportional term | 73 1F 8A FF | PROM DEFAULT | PROM DEFAULT | 10893 |
| 87 | RDM scan initial control error | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108C1 |
| 88 | RDM scan initial integral term | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108C3 |
| 89 | RDM scan initial derivative term | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108C5 |
| 90 | RDM cogging torque correction 2 amplitude | 00 00 00 00 | PROM DEFAULT | 5A 1C AC FA | 108D7 |
| 91 | RDM cogging torque correction 2 frequency | 00 00 00 00 | PROM DEFAULT | 60 00 00 04 | 108DF |
| 92 | RDM cogging torque correction 2 phase | 00 00 00 00 | PROM DEFAULT | 78 00 00 08 | 108E7 |
| 93 | RDM cogging torque correction 3 amplitude | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108D9 |
| 94 | RDM cogging torque correction 3 frequency | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108E1 |
| 95 | RDM cogging torque correction 3 phase | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108E9 |
| 96 | RDM cogging torque correction 4 amplitude | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108DB |
| 97 | RDM cogging torque correction 4 frequency | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108E3 |

| SCT Item | Description | PROM<br><br>Value<br><br>(hex) | PFM (after Loads)<br><br>(hex) | FM2 (after Loads)<br><br>(hex) | Address<br><br>(hex) |
|---|---|---|---|---|---|
| 98 | RDM cogging torque correction 4 phase | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108EB |
| 99 | RDM cogging torque correction 4 amplitude | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108D0 |
| 100 | RDM cogging torque correction 4 frequency | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108E5 |
| 101 | RDM cogging torque correction 4 phase | 00 00 00 00 | PROM DEFAULT | PROM DEFAULT | 108Ed |

## TABLE 11.2 MHS DC Offset Table (DOT) – See Appendix D of 'JA063'

| DOT Item | Description | PROM Value (hex) | PFM (after Loads) (hex) | FM2 (after Loads) (hex) | Address (hex) |
|---|---|---|---|---|---|
| 0 | Channel H1 thru H4 DC Offsets | 5A D1 AB BA | 3F 5E 46 27 | 3F 55 56 4C | 10810 - 10813 |
| 1 | Channel 5 DC Offset; SPE Channel Gain; Ideal Cal Mid-Point | AE 85 73 2C | 57 82 73 2C | 38 82 73 2C | 10814; 107E6; 107E5 |
| 2 | Upper & Lower Dead bands | F3 24 0C CC | PROM DEFAULT | PROM DEFAULT | 107E1; 107E2 |
| 3 | Max & Min Dynamic Range | E6 58 BF F4 | E6 58 7F F8 | E6 58 7F F8 | 107E3; 107E4 |

## 12. ADDITIONAL RESOURCES/ISSUES

### 12.1. MIU-AIP Data Word Ordering Anomaly

**Anomaly Overview:** The AIP provides a serial data stream from the spacecraft, which may be transmitted to the ground or embedded into other composite data streams. Within the AIP data, information is collected from the TIP, AMSU-A1, AMSU-A2, and the MIU. The TIP controls the basic data frame timing, generating a minor frame every tenth of a second (in Orbit Mode) and repeating the entire sequence every 32 seconds, called a major frame. The AIP is synchronized to the TIP timing using the 32-second major frame synch, and the harmonically related one-tenth second (10 Hz) pulse. The AIP itself has an 8-second major frame, which means it repeats its sequence four times during a TIP major frame.

Since the TIP and AIP minor frames are both 10 Hz, they are locked together, using the TIP synch timing. The TIP 32-second major frame pulse synchronizes the AIP. AIP generates its own 8-second timing, but since that period is harmonically related, it will not drift significantly from the 32-second pulse. AIP keeps the data from the AMSU's and MIU synchronized by passing on the timing pulses as appropriate.

The AIP stores the data from all four inputs in serial buffers during one minor frame, and sequences it into the data steam in the subsequent frame. This is mechanized using two sets of alternate buffers. AIP will initiate the data transfer with the 10 Hz synch, followed by the appropriate number of word strobes - 56 in the case of the MIU. The synch serves only to define the start of the transfer. The actual timing of the strobes will differ for each data source, and in the case of the MIU may not even be continuous, but it will always follow the synch.

The MIU provides a total of 80 sets of 56 8-bit words, called minor cycles, each of which will be inserted in an AIP minor frame. A minor cycle counter within the MIU keeps track of the frame sequence, and its content is included in the 56-word data sequence. Because of the double buffer arrangement, the MIU minor cycle count may not agree exactly with the AIP minor frame. However, the 8-second synch pulse will ensure that they are sequencing together uniformly, counting the same 80 frames.

The 56-word count is synchronized using the 10 Hz pulse, so that the first word will be transferred by the strobe following the synch. The data from the MHS is partially synchronized to the TIP timing, but the MS-1553 interface bus and MHS scanning mechanics prevent an exact match. Therefore, the MIU receives the MHS data packets, and packages them along with housekeeping telemetry, to produce the 56-word AIP data.

The 10 Hz and the 8-second synch pulses are received at the MIU and applied to the software using two discrete interrupts. Although both signals are intended to be continuous over long periods, a change in system clocking may result in a jump in either one, which causes it to be early or late with respect to previous pulse timing. The MIU is expected to resynchronize itself to the new sequence.

The problem experienced in thermal vacuum testing come from a switch between redundant AIP circuitry. For long-term reliability, TIROS system hardware provides a replacement functional unit for many components. This precaution is not applied to everything for economic reasons. E. g., there is only one MIU available. However, the AIP, TIP and some others may be replaced when necessary. This feature is fully exercised during system functional and environmental testing. When the AIP redundant sides are switched, it has been found that the 56-word counter is not always reset to the 10 Hz synch. Therefore, the data words are out of sequence and arrive at the AIP in the wrong location.

The reliable solution is: Command the MHS (if in operation) into the SAFE state or ON state (if OFF do not turn ON), and then issue the MIU RESET Command (Soft Reset). After MIU is re-initialized enabling the BC Bus, re-sequence the MHS into the previous mode of operation.

**TABLE 12.1 MHS Housekeeping Packet Status Telemetry**

| TLM ID | DESCRIPTION | '0' | '1' | MHS-TN-JA063-MMP Ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHK 2 | Hk Pie Id | Pie A | Pie B | Figure 4.2.2.1-2 | 174 |
| MHK 5 | Tc Ack Cln Flg | Dirty | Cln | Figure 4.2.2.1-4 | 174 |
| MHK 6 | Tc Ack Cnf Flg | Ncnf | Cnfm | Figure 4.2.2.1-4 | 174 |
| MHK 7 | Tc Ack Rec Flg | Nrec | Rcon | Figure 4.2.2.1-4 | 174 |
| MHK 8 | Tc Ack Leg Flg | Nlgl | Lglc | Figure 4.2.2.1-4 | 174 |
| MHK 12 | Fc Current Mon | Psok | Falt | Figure 4.2.2.1-4 | 180 |
| MHK 13 | Fc Thrmstr Mon | Trok | Falt | Figure 4.2.2.1-4 | 180 |
| MHK 14 | Fc Swtch Fault | Swok | Falt | Figure 4.2.2.1-4 | 180 |
| MHK 15 | Fc Proc Fault | Prok | Falt | Figure 4.2.2.1-4 | 180 |
| MHK 16 | Fc Dc Ofst Err | Dcok | Err | Figure 4.2.2.1-4 | 180 |
| MHK 17 | Fc Scn Con Err | Scok | Falt | Figure 4.2.2.1-4 | 180 |
| MHK 18 | Fc Ref Clk Err | Clok | Falt | Figure 4.2.2.1-4 | 180 |
| MHK 19 | Fc Rdm Mtr Trp | Rmok | Falt | Figure 4.2.2.1-4 | 180 |
| MHK 20 | Fc Fdm Mtr Trp | Fmok | Falt | Figure 4.2.2.1-4 | 180 |
| MHK 21 | Fc Prm Swt Err | Pmok | Err | Figure 4.2.2.1-4 | 180 |
| MHK 22 | Rcvr Ch1 Stat | Off | On | Figure 5.1-1 chan 1:1 | 183 |
| MHK 23 | Rcvr Ch1 Lo | Sd-A | Sd-B | Figure 5.1-1 chan 1:2 | 183 |
| MHK 24 | Rcvr Ch2 Stat | Off | On | Figure 5.1-1 chan 1:3 | 183 |
| MHK 25 | Rcvr Ch2 Lo | Sd-A | Sd-B | Figure 5.1-1 chan 1:4 | 183 |
| MHK 26 | Rcvr Ch3/4 Fe | Off | On | Figure 5.1-1 chan 1:5 | 183 |
| MHK 27 | Rcvr Ch3/4 Lo | Sd-A | Sd-B | Figure 5.1-1 chan 1:6 | 183 |
| MHK 28 | Rcvr Ch3 Bken | Off | On | Figure 5.1-1 chan 1:7 | 183 |
| MHK 29 | Rcvr Ch4 Bken | Off | On | Figure 5.1-1 chan 1:8 | 183 |
| MHK 30 | Rcvr Ch5 Stat | Off | On | Figure 5.1-1 chan 1:9 | 183 |
| MHK 31 | Rcvr Ch5 Lo | Sd-A | Sd-B | Figure 5.1-1 chan 1:10 | 183 |
| MHK 32 | Rx Cv On/Off | Off | On | Figure 5.1-1 chan 1:11 | 180,183 |
| MHK 33 | Rcvr Op Htrs | Off | On | Figure 5.1-2 chan 2:1 | 180,183 |
| MHK 34 | Scn Mch Ophtrs | Off | On | Figure 5.1-2 chan 2:2 | 180 |
| MHK 35 | Aux Op Htrs | Off | On | Figure 5.1-2 chan 2:3 | 180 |
| MHK 36 | Spe/Sce On/Off | Off | On | Figure 5.1-2 chan 2:4 | 180 |
| MHK 38 | Rdm 0 Pos Snsr | Sd-A | Sd-B | Figure 5.1-3 chan 3:4 | 180,181 |
| MHK 39 | Fdm 0 Pos Snsr | Sd-A | Sd-B | Figure 5.1-3 chan 3:5 | 180,181 |
| MHK 40 | Rdm 0 Mtr Snsr | Sd-A | Sd-B | Figure 5.1-3 chan 3:6 | 180,181 |
| MHK 41 | Fdm 0 Mtr Snsr | Sd-A | Sd-B | Figure 5.1-3 chan 3:7 | 180,181 |
| MHK 42 | Rdm Mtr Sply | Off | On | Figure 5.1-3 chan 3:8 | 180,181 |

| TLM ID | DESCRIPTION | ' 0 ' | ' 1 ' | MHS-TN-JA063-MMP Ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHK 43 | Fdm Mtr Sply | Off | On | Figure 5.1-3 chan 3:9 | 180,181 |
| MHK 44 | Rdm Mtr I Trip | Enbl | Dsbl | Figure 5.1-3 chan 3:10 | 180,181 |
| MHK 45 | Fdm Mtr I Trip | Enbl | Dsbl | Figure 5.1-3 chan 3:11 | 180,181 |
| MHK 46 | Rdmmtr I Trpst | Ntrp | Trip | Figure 5.1-3 chan 3:12 | 181 |
| MHK 47 | Fdmmtr I Trpst | Ntrp | Trip | Figure 5.1-3 chan 3:13 | 181 |
| MHK 113 | TstID Datatype | Dmnd | Psdt | Sections 4.2.2.3 & 4.3.2.3 | 175 |
| MHK 114 | TstID Dataprec | 16bt | 18bt | Sections 4.2.2.3 & 4.3.2.3 | |
| MHK 115 | TstID Motor | Fdm | Rdm | Sections 4.2.2.3 & 4.3.2.3 | |
| MHK 116 | TstID Profile | Ptbl | Cnvl | Sections 4.2.2.3 & 4.3.2.3 | |
| MHK 750 | Memory Test | Notd | Done | Section 4.2.2.3 | |
| MHK 751 | Processor Test | Notd | Done | Section 4.2.2.3 | |
| MHK 752 | Switch TMTC Test | Notd | Done | Section 4.2.2.3 | |
| MHK 753 | Memory Test | Fail | Pass | Section 4.2.2.3 | |
| MHK 754 | Processor Test | Fail | Pass | Section 4.2.2.3 | |
| MHK 755 | Swtch TMTC Test | Fail | Pass | Section 4.2.2.3 | |
| MHK 763 | Edac Test | Fail | Pass | Section 4.2.2.3 | |
| MHK 764 | Cpu Test | Fail | Pass | Section 4.2.2.3 | |
| MHK 765 | Reset Source | Othr | HW | Section 4.2.2.3 | |
| MHK 766 | PCC Test | Fail | Pass | Section 4.2.2.3 | |
| MHK 767 | BIC Test | Fail | Pass | Section 4.2.2.3 | |
| MHK 771 | Swtch TMTC Ch1 | Fail | Pass | Section 4.2.2.3 | |
| MHK 772 | Swtch TMTC Ch2 | Fail | Pass | Section 4.2.2.3 | |
| MHK 773 | Swtch TMTC Ch3 | Fail | Pass | Section 4.2.2.3 | |
| MHK 774 | Swtch TMTC Ch4 | Fail | Pass | Section 4.2.2.3 | |
| MHK 775 | Swtch TMTC Ch5 | Fail | Pass | Section 4.2.2.3 | |
| MHK 776 | Swtch TMTC Ch6 | Fail | Pass | Section 4.2.2.3 | |
| MHK 777 | Swtch TMTC Ch7 | Fail | Pass | Section 4.2.2.3 | |
| MHK 778 | Swtch TMTC Ch8 | Fail | Pass | Section 4.2.2.3 | |
| MHK 779 | Swtch TMTC Ch9 | Fail | Pass | Section 4.2.2.3 | |
| MHK 780 | Swtch TMTC Ch10 | Fail | Pass | Section 4.2.2.3 | |
| MHK 781 | Swtch TMTC Ch11 | Fail | Pass | Section 4.2.2.3 | |
| MHK 782 | Swtch TMTC Ch12 | Fail | Pass | Section 4.2.2.3 | |
| MHK 783 | Swtch TMTC Ch13 | Fail | Pass | Section 4.2.2.3 | |
| MHK 784 | Swtch TMTC Ch14 | Fail | Pass | Section 4.2.2.3 | |
| MHK 785 | Swtch TMTC Ch15 | Fail | Pass | Section 4.2.2.3 | |
| MHK 786 | Swtch TMTC Ch16 | Fail | Pass | Section 4.2.2.3 | |
| MHK 787 | Swtch TMTC Ch17 | Fail | Pass | Section 4.2.2.3 | |
| MHK 788 | Swtch TMTC Ch18 | Fail | Pass | Section 4.2.2.3 | |
| MHK 789 | Swtch TMTC Ch19 | Fail | Pass | Section 4.2.2.3 | |
| MHK 790 | Swtch TMTC Ch20 | Fail | Pass | Section 4.2.2.3 | |

## TABLE 12.2 MHS Science Packet Status Telemetry

| TLM ID | DESCRIPTION | '0' | '1' | MHS-TN-JA063-MMP Ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHS 2 | Hk Pie ID | Pie A | Pie B | Figure 4.2.2.1-2 | 174,175,178 |
| MHS 5 | Tc Ack Cln Flg | Drty | Cln | Figure 4.2.2.1-4 | 174 |
| MHS 6 | Tc Ack Cnf Flg | Ncnf | Cnfm | Figure 4.2.2.1-4 | 174 |
| MHS 7 | Tc Ack Rec Flg | Nrec | Rcon | Figure 4.2.2.1-4 | 174 |
| MHS 8 | Tc Ack Leg Flg | Nlgl | Lglc | Figure 4.2.2.1-4 | 174 |
| MHS 12 | Fc Current Mon | Psok | Falt | Figure 4.2.2.1-4 | 175 |
| MHS 13 | Fc Thrmstr Mon | Trok | Falt | Figure 4.2.2.1-4 | 175 |
| MHS 14 | Fc Swtch Falt | Swok | Falt | Figure 4.2.2.1-4 | 175 |
| MHS 15 | Fc Proc Falt | Prok | Falt | Figure 4.2.2.1-4 | 175 |
| MHS 16 | Fc Dc Ofst Err | Dcok | Err | Figure 4.2.2.1-4 | 175 |
| MHS 17 | Fc Scn Con Err | Scok | Falt | Figure 4.2.2.1-4 | 175 |
| MHS 18 | Fc Ref Clk Err | Clok | Falt | Figure 4.2.2.1-4 | 175 |
| MHS 19 | Fc Rdm Mtr Trp | Rmok | Falt | Figure 4.2.2.1-4 | 175 |
| MHS 20 | Fc Fdm Mtr Trp | Fmok | Falt | Figure 4.2.2.1-4 | 175 |
| MHS 21 | Fc Prm Swt Err | Pmok | Err | Figure 4.2.2.1-4 | 175 |
| MHS 22 | Rcvr Ch1 Stat | Off | On | Figure 5.1-1 chan 1:1 | 178 |
| MHS 23 | Rcvr Ch1 Lo | Sd-A | Sd-B | Figure 5.1-1 chan 1:2 | 178 |
| MHS 24 | Rcvr Ch2 Stat | Off | On | Figure 5.1-1 chan 1:3 | 178 |
| MHS 25 | Rcvr Ch2 Lo | Sd-A | Sd-B | Figure 5.1-1 chan 1:4 | 178 |
| MHS 26 | Rcvr Ch3/4 Fe | Off | On | Figure 5.1-1 chan 1:5 | 178 |
| MHS 27 | Rcvr Ch3/4 Lo | Sd-A | Sd-B | Figure 5.1-1 chan 1:6 | 178 |
| MHS 28 | Rcvr Ch3 Bken | Off | On | Figure 5.1-1 chan 1:7 | 178 |
| MHS 29 | Rcvr Ch4 Bken | Off | On | Figure 5.1-1 chan 1:8 | 178 |
| MHS 30 | Rcvr Ch5 Stat | Off | On | Figure 5.1-1 chan 1:9 | 178 |
| MHS 31 | Rcvr Ch5 Lo | Sd-A | Sd-B | Figure 5.1-1 chan 1:10 | 175 |
| MHS 32 | Rx Cv On/Off | Off | On | Figure 5.1-1 chan 1:11 | 175,178 |
| MHS 33 | Rcvr Op Htrs | Off | On | Figure 5.1-2 chan 2:1 | 175,178 |
| MHS 34 | Scn Mch Ophtrs | Off | On | Figure 5.1-2 chan 2:2 | 175 |
| MHS 35 | Aux Op Htrs | Off | On | Figure 5.1-2 chan 2:3 | 175 |
| MHS 36 | Spe/Sce On/Off | Off | On | Figure 5.1-2 chan 2:4 | 175 |
| MHS 38 | Rdm 0 Pos Snsr | Sd-A | Sd-B | Figure 5.1-3 chan 3:4 | 175,176 |
| MHS 39 | Fdm 0 Pos Snsr | Sd-A | Sd-B | Figure 5.1-3 chan 3:5 | 175,176 |
| MHS 40 | Rdm 0 Mtr Snsr | Sd-A | Sd-B | Figure 5.1-3 chan 3:6 | 175,176 |
| MHS 41 | Fdm 0 Mtr Snsr | Sd-A | Sd-B | Figure 5.1-3 chan 3:7 | 175,176 |
| MHS 42 | Rdm Mtr Sply | Off | On | Figure 5.1-3 chan 3:8 | 175,176 |
| MHS 43 | Fdm Mtr Sply | Off | On | Figure 5.1-3 chan 3:9 | 175,176 |
| MHS 44 | Rdm Mtr I Trip | Enbl | Dsbl | Figure 5.1-3 chan 3:10 | 175,176 |
| MHS 45 | Fdm Mtr I Trip | Enbl | Dsbl | Figure 5.1-3 chan 3:11 | 175,176 |
| MHS 46 | Rdmmtr I Trpst | Ntrp | Trip | Figure 5.1-3 chan 3:12 | 176 |
| MHS 47 | Fdmmtr I Trpst | Ntrp | Trip | Figure 5.1-3 chan 3:13 | 176 |
| MHS 100 | Dc Ofst Vldflg | Nvld | Vld | Figure 4.3.2.1-2 | 176,178 |
| MHS 101 | Scn Con Vldflg | Nvld | Vld | Figure 4.3.2.1-2 | 176 |
| MHS 108 | Ch/H1 Vld | Nvld | Vld | Figure 4.3.2.1-3 | 178 |
| MHS 109 | Ch/H2 Vld | Nvld | Vld | Figure 4.3.2.1-3 | 178 |

| TLM ID | DESCRIPTION | '0' | '1' | MHS-TN-JA063-MMP Ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHS 110 | Ch/H3 Vld | Nvld | Vld | Figure 4.3.2.1-3 | 178 |
| MHS 111 | Ch/H4 Vld | Nvld | Vld | Figure 4.3.2.1-3 | 178 |
| MHS 112 | Ch/H5 Vld | Nvld | Vld | Figure 4.3.2.1-3 | 178 |
| MHS 113 | TstID Datatype | Dmnd | Psdt | Section 4.3.2.3 | 175 |
| MHS 114 | TstID Dataprec | 16bt | 18bt | Section 4.3.2.3 | 186 |
| MHS 115 | TstID Motor | Fdm | Rdm | Section 4.3.2.3 | 186 |
| MHS 116 | TstID Profile | Ptbl | Cnvl | Section 4.3.2.3 | 186 |
| MHS 726 | Tstid Datatype | Dmnd | Pdat | Section 4.3.2.3 | 186 |
| MHS 727 | Tstid Dataprec | 16bit | 18bit | Section 4.3.2.3 | 186 |
| MHS 728 | Tstid Motor | Fdm | Rdm | Section 4.3.2.3 | |
| MHS 729 | Tstid Pro Type | Ptbl | Cnvl | Section 4.3.2.3 | |
| MHS 750 | Memory Test | Notd | Done | Section 4.2.2.3 | |
| MHS 751 | Processor Test | Notd | Done | Section 4.2.2.3 | |
| MHS 752 | Switch TMTC Test | Notd | Done | Section 4.2.2.3 | |
| MHS 753 | Memory Test | Fail | Pass | Section 4.2.2.3 | |
| MHS 754 | Processor Test | Fail | Pass | Section 4.2.2.3 | |
| MHS 755 | Swtch TMTC Test | Fail | Pass | Section 4.2.2.3 | |
| MHS 763 | Edac Test | Fail | Pass | Section 4.2.2.3 | |
| MHS 764 | Cpu Test | Fail | Pass | Section 4.2.2.3 | |
| MHS 765 | Reset Source | Othr | HW | Section 4.2.2.3 | |
| MHS 766 | PCC Test | Fail | Pass | Section 4.2.2.3 | |
| MHS 767 | BIC Test | Fail | Pass | Section 4.2.2.3 | |
| MHS 771 | Swtch TMTC Ch1 | Fail | Pass | Section 4.2.2.3 | |
| MHS 772 | Swtch TMTC Ch2 | Fail | Pass | Section 4.2.2.3 | |
| MHS 773 | Swtch TMTC Ch3 | Fail | Pass | Section 4.2.2.3 | |
| MHS 774 | Swtch TMTC Ch4 | Fail | Pass | Section 4.2.2.3 | |
| MHS 775 | Swtch TMTC Ch5 | Fail | Pass | Section 4.2.2.3 | |
| MHS 776 | Swtch TMTC Ch6 | Fail | Pass | Section 4.2.2.3 | |
| MHS 777 | Swtch TMTC Ch7 | Fail | Pass | Section 4.2.2.3 | |
| MHS 778 | Swtch TMTC Ch8 | Fail | Pass | Section 4.2.2.3 | |
| MHS 779 | Swtch TMTC Ch9 | Fail | Pass | Section 4.2.2.3 | |
| MHS 780 | Swtch TMTC Ch10 | Fail | Pass | Section 4.2.2.3 | |
| MHS 781 | Swtch TMTC Ch11 | Fail | Pass | Section 4.2.2.3 | |
| MHS 782 | Swtch TMTC Ch12 | Fail | Pass | Section 4.2.2.3 | |
| MHS 783 | Swtch TMTC Ch13 | Fail | Pass | Section 4.2.2.3 | |
| MHS 784 | Swtch TMTC Ch14 | Fail | Pass | Section 4.2.2.3 | |
| MHS 785 | Swtch TMTC Ch15 | Fail | Pass | Section 4.2.2.3 | |
| MHS 786 | Swtch TMTC Ch16 | Fail | Pass | Section 4.2.2.3 | |
| MHS 787 | Swtch TMTC Ch17 | Fail | Pass | Section 4.2.2.3 | |
| MHS 788 | Swtch TMTC Ch18 | Fail | Pass | Section 4.2.2.3 | |
| MHS 789 | Swtch TMTC Ch19 | Fail | Pass | Section 4.2.2.3 | |
| MHS 790 | Swtch TMTC Ch20 | Fail | Pass | Section 4.2.2.3 | |

**TABLE 12.3 MHS Housekeeping Packet Serial(Non-Bilevel) Telemetry**

| TLM | ID | | DESCRIPTION | MHS-TN-JA063-MMP ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHK | 1 | | MHS Mode Code | Figure 4.2.2.1-3 | 173,174,175,180 |
| MHK | 3 | | Hk Subcom Code | Figure 4.2.2.1-2 | 174,180 |
| MHK | 4 | | Hk Selftest Code | Section 4.2.2..3 | 173,174,180 |
| MHK | 9 | | Tc Ack App Id | Figure 4.2.2.1-4 | 174 |
| MHK | 10 | | Tc Ack Pkt Seq | Figure 4.2.2.1-4 | 174 |
| MHK | 11 | | Tc Ack Rcvd Ct | Figure 4.2.2.1-4 | 174 |
| MHK | 37 | | Spe Mux Code | Figure 4.3.2.1-4 & Figure 5.1-3 | 180 |
| MHK | 48 | | Lo H1 Temp Qbs1 | Figure 5.2-1 chan 4:1 | 182 |
| MHK | 49 | | Lo H2 Temp Qbs2 | Figure 5.2-1 chan 4:2 | 182 |
| MHK | 50 | | Lo H3/4 Temp | Figure 5.2-1 chan 4:3 | 182 |
| MHK | 51 | | Lo H5 Temp Qbs5 | Figure 5.2-1 chan 4:4 | 182 |
| MHK | 52 | | Mx/Lna H1 Temp | Figure 5.2-1 chan 4:5 | 182 |
| MHK | 53 | | Mx/Lna H2 Temp | Figure 5.2-1 chan 4:6 | 182 |
| MHK | 54 | | Mx/Lna H3/4 Temp | Figure 5.2-1 chan 4:7 | 182 |
| MHK | 55 | | Mx/Lna H5 Temp | Figure 5.2-1 chan 4:8 | 182 |
| MHK | 56 | | Q/O Bsplt Temp1 | Figure 5.2-1 chan 4:9 | 182 |
| MHK | 57 | | Q/O Bsplt Temp2 | Figure 5.2-1 chan 4:10 | 182 |
| MHK | 58 | | If Bsplt Temp 1 | Figure 5.2-1 chan 4:11 | 182 |
| MHK | 59 | | If Bsplt Temp 2 | Figure 5.2-1 chan 4:12 | 182 |
| MHK | 60 | | Rdm Motor Temp | Figure 5.2-1 chan 4:13 | 181,182 |
| MHK | 61 | | Fdm Motor Temp | Figure 5.2-1 chan 4:14 | 181,182 |
| MHK | 62 | | Rdm Sshm Temp | Figure 5.2-1 chan 4:15 | 182 |
| MHK | 63 | | Fdm Sshm Temp | Figure 5.2-1 chan 4:16 | 182 |
| MHK | 64 | | Struct 1 Temp | Figure 5.2-1 chan 4:17 | 182 |
| MHK | 65 | | Struct 2 Temp | Figure 5.2-1 chan 4:18 | 182 |
| MHK | 66 | | Struct 3 Temp | Figure 5.2-1 chan 4:19 | 182 |
| MHK | 67 | | Proc Module Temp | Figure 5.2-1 chan 4:20 | 182 |
| MHK | 68 | | Mn Dc/Dc Cn Tm | Figure 5.2-1 chan 4:21 | 182 |
| MHK | 69 | | Sce Rdm Md Temp | Figure 5.2-1 chan 4:22 | 182 |
| MHK | 70 | | Sce Fdm Md Temp | Figure 5.2-1 chan 4:23 | 182 |
| MHK | 71 | | Rf Dc/Dc Converter Temp | Figure 5.2-1 chan 4:24 | 182 |
| MHK | 74 | | Ee+Sm +5v Current | Figure 4.2.2.1-6 | 183 |
| MHK | 78 | | Rx Global Pwr | Figure 4.2.2.1-6 | 183 |
| MHK | 79 | | Total Mtr Current | Figure 4.2.2.1-6 | 181 |
| MHK | 80 | | Not Used in HK | N/A | N/A |
| MHK | 81 | | PRT 2 | Figure 5.4-1 | 182 |
| MHK | 82 | | PRT 3 | Figure 5.4-1 | 182 |
| MHK | 83 | | PRT 4 | Figure 5.4-1 | 182 |
| MHK | 84 | | PRT 5 | Figure 5.4-1 | 182 |
| MHK | 85 | | Not used in HK | N/A | N/A |
| MHK | 86 | | Not used in HK | N/A | N/A |
| MHK | 87 | | Not used in HK | N/A | N/A |
| MHK | 88 | | Hk Mode Code | Figure 4.2.2.1-3 | 180,181,183 |

| TLM ID | | | DESCRIPTION | MHS-TN-JA063-MMP ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHK | 89 | | Hk Pkt Checksum | Section 4.1.3 | |
| MHK | 90 | | Mdp St Add Msb | Figure 4.2.2.2-1 | 174,184 |
| MHK | 91 | | Mdp St Add | Figure 4.2.2.2-1 | 174,184 |
| MHK | 92 | | Mdp St Add Lsb | Figure 4.2.2.2-1 | 174,184 |
| MHK | 93 | | Mdp Dt Wd1 | Figure 4.2.2.2-1 | 184 |
| MHK | 94 | | Mdp Dt Wd2 | Figure 4.2.2.2-1 | 184 |
| MHK | 95 | | Mdp Dt Wd3 | Figure 4.2.2.2-1 | 184 |
| MHK | 96 | | Mdp Dt Wd4 | Figure 4.2.2.2-1 | 184 |
| MHK | 97 | | Tdp Dt Wd1 | Section 4.2.2.3 | 173,184 |
| MHK | 98 | | Tdp Dt Wd2 | Section 4.2.2.3 | 173,184 |
| MHK | 99 | | Tdp Dt Wd3 | Section 4.2.2.3 | 173,184 |
| MHK | 100 | | Tdp Dt Wd4 | Section 4.2.2.3 | 173,184 |
| MHK | 101 | | Tdp Dt Wd5 | Section 4.2.2.3 | 173,184 |
| MHK | 102 | | Tdp Dt Wd6 | Section 4.2.2.3 | 173,184 |
| MHK | 103 | | Tdp Dt Wd7 | Section 4.2.2.3 | 173,184 |
| MHK | 104 | | Tdp Dt Wd8 | Section 4.2.2.3 | 173,184 |
| MHK | 105 | | Tdp Dt Wd9 | Section 4.2.2.3 | 173,184 |
| MHK | 106 | | Tdp Dt Wd10 | Section 4.2.2.3 | 173,184 |
| MHK | 107 | | Tdp Dt Wd11 | Section 4.2.2.3 | 173,184 |
| MHK | 108 | | Tdp Dt Wd12 | Section 4.2.2.3 | 173,184 |
| MHK | 109 | | Tdp Dt Wd13 | Section 4.2.2.3 | 173,184 |
| MHK | 110 | | Tdp Dt Wd14 | Section 4.2.2.3 | 173,184 |
| MHK | 111 | | Tdp Dt Wd15 | Section 4.2.2.3 | 173,184 |
| MHK | 112 | | Test ID Word | Section 4.2.2.3 | 174 |
| MHK | 117 | | Tstid Profile | Sections 4.2.2.3 & 4.3.2.3 | |
| MHK | 118 | | Tsid Start Bl | Sections 4.2.2.3 & 4.3.2.3 | |
| MHK | 758 | | Tst S-Add MSB Hex | Section 4.2.2.3 | |
| MHK | 759 | | Tst S Add LSW Hex | Section 4.2.2.3 | |
| MHK | 760 | | Tst E-Add MSB Hex | Section 4.2.2.3 | |
| MHK | 761 | | Tst E-add LSW Hex | Section 4.2.2.3 | |
| MHK | 762 | | Num Errors | Section 4.2.2.3 | |
| MHK | 795 | | Tst Start Addr Hex | Section 4.2.2.3 | |
| MHK | 796 | | Tst End Addr Hex | Section 4.2.2.3 | |
| MHK | 797 | | PRT1 Sampl 120 cnts | Section 4.2.2.3 | |
| MHK | 798 | | PRT2 Sampl 120 cnts | Section 4.2.2.3 | |
| MHK | 799 | | PRT3 Sampl 120 cnts | Section 4.2.2.3 | |
| MHK | 800 | | PRT4 Sampl 120 cnts | Section 4.2.2.3 | |
| MHK | 801 | | PRT5 Sampl 120 cnts | Section 4.2.2.3 | |
| MHK | 802 | | Cal Channel 1 cnts | Section 4.2.2.3 | |
| MHK | 803 | | Cal Channel 2 cnts | Section 4.2.2.3 | |
| MHK | 804 | | Sam 1 Pos Data | Section 4.2.2.3 | |
| MHK | 805 | | Sam 2 Pos Data | Section 4.2.2.3 | |
| MHK | 806 | | Sam 3 Pos Data | Section 4.2.2.3 | |
| MHK | 807 | | Sam 4 Pos Data | Section 4.2.2.3 | |
| MHK | 808 | | Sam 5 Pos Data | Section 4.2.2.3 | |
| MHK | 809 | | Sam 6 Pos Data | Section 4.2.2.3 | |
| MHK | 810 | | Sam 7 Pos Data | Section 4.2.2.3 | |
| MHK | 811 | | Sam 1 CD Data | Section 4.2.2.3 | |

| TLM ID | | | DESCRIPTION | MHS-TN-JA063-MMP ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHK | 812 | | Sam 2 CD Data | Section 4.2.2.3 | |
| MHK | 813 | | Sam 3 CD Data | Section 4.2.2.3 | |
| MHK | 814 | | Sam 4 CD Data | Section 4.2.2.3 | |
| MHK | 815 | | Sam 5 CD Data | Section 4.2.2.3 | |
| MHK | 816 | | Sam 6 CD Data | Section 4.2.2.3 | |
| MHK | 817 | | Sam 7 CD Data | Section 4.2.2.3 | |
| MHK | 998 | | Coarse Time | Figure 4.1.2-1 | 174 |
| MHK | 999 | | Fine Time | Figure 4.1.2-1 | 174 |
| MHK | 1000 | | MHK LRI Status | N/A - NAGE use only | |

## TABLE 12.4 MHS Science Packet Serial(Non-Bilevel) Telemetry

| TLM ID | | | DESCRIPTION | MHS-TN-JA063-MMP ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHS | 1 | | MHS Mode Code | Figure 4.2.2.1-2 | 173,174,175 |
| MHS | 3 | | Hk Subcom Code | Figure 4.2.2.1-2 | 174,175 |
| MHS | 4 | | Hk Selftst Code | Figure 4.2.2.1-2 | 173,174,175 |
| MHS | 9 | | Tc Ack App Id Hex | Figure 4.2.2.1-4 | 174 |
| MHS | 10 | | Tc Ack Pkt Seq Hex | Figure 4.2.2.1-4 | 174 |
| MHS | 11 | | Tc Ack Rcvd Ct Hex | Figure 4.2.2.1-4 | 174 |
| MHS | 37 | | Spe Mux Code Hex | Figure 4.2.2.1-4 | 175 |
| MHS | 48 | | Lo H1 Temp Qbs1 | Figure 5.2-1 chan 4:1 | 177 |
| MHS | 49 | | Lo H2 Temp Qbs2 | Figure 5.2-1 chan 4:2 | 177 |
| MHS | 50 | | Lo H3/4 Temp | Figure 5.2-1 chan 4:3 | 177 |
| MHS | 51 | | Lo H5 Temp Qbs5 | Figure 5.2-1 chan 4:4 | 177 |
| MHS | 52 | | Mx/Lna H1 Temp | Figure 5.2-1 chan 4:5 | 177 |
| MHS | 53 | | Mx/Lna H2 Temp | Figure 5.2-1 chan 4:6 | 177 |
| MHS | 54 | | Mx/Lna H3/4 Temp | Figure 5.2-1 chan 4:7 | 177 |
| MHS | 55 | | Mx/Lna H5 Temp | Figure 5.2-1 chan 4:8 | 177 |
| MHS | 56 | | Q/O Bsplt Temp1 | Figure 5.2-1 chan 4:9 | 177 |
| MHS | 57 | | Q/O Bsplt Temp2 | Figure 5.2-1 chan 4:10 | 177 |
| MHS | 58 | | If Bsplt Temp 1 | Figure 5.2-1 chan 4:11 | 177 |
| MHS | 59 | | If Bsplt Temp 2 | Figure 5.2-1 chan 4:12 | 177 |
| MHS | 60 | | Rdm Motor Temp | Figure 5.2-1 chan 4:13 | 176,177 |
| MHS | 61 | | Fdm Motor Temp | Figure 5.2-1 chan 4:14 | 176,177 |
| MHS | 62 | | Rdm Sshm Temp | Figure 5.2-1 chan 4:15 | 177 |
| MHS | 63 | | Fdm Sshm Temp | Figure 5.2-1 chan 4:16 | 177 |
| MHS | 64 | | Struct 1 Temp | Figure 5.2-1 chan 4:17 | 177 |
| MHS | 65 | | Struct 2 Temp | Figure 5.2-1 chan 4:18 | 177 |
| MHS | 66 | | Struct 3 Temp | Figure 5.2-1 chan 4:19 | 177 |
| MHS | 67 | | Proc Mod Temp | Figure 5.2-1 chan 4:20 | 177 |
| MHS | 68 | | Mn Dc/Dc Cn Temp | Figure 5.2-1 chan 4:21 | 177 |
| MHS | 69 | | Sce Rdm Md Temp | Figure 5.2-1 chan 4:21 | 176,177 |
| MHS | 70 | | Sce Fdm Md Temp | Figure 5.2-1 chan 4:22 | 176,177 |
| MHS | 71 | | Rf Dc/Dc Conv Temp | Figure 5.2-1 chan 4:23 | 177 |
| MHS | 72 | | Rdm Motor Current | Figure 5.3-1 chan 5:1 | 176 |
| MHS | 73 | | Fdm Motor Current | Figure 5.3-1 chan 5:2 | 176 |
| MHS | 74 | | Ee+Sm +5v Current | Figure 4.2.2.1-6 | 178 |
| MHS | 75 | | Rcvr +8 V Current | Figure 4.2.2.1-6 | 178 |
| MHS | 76 | | Rcvr +15v Current | Figure 4.2.2.1-6 | 178 |
| MHS | 77 | | Rcvr -15v Current | Figure 4.2.2.1-6 | 178 |
| MHS | 78 | | Not Used for Science Data | N/A | N/A |
| MHS | 79 | | Not Used for Science Data | N/A | N/A |
| MHS | 80 | | PRT 1 | Figure 5.4-1 | 177 |
| MHS | 81 | | PRT 2 | Figure 5.4-1 | 177 |
| MHS | 82 | | PRT 3 | Figure 5.4-1 | 177 |
| MHS | 83 | | PRT 4 | Figure 5.4-1 | 177 |

| TLM ID | | | DESCRIPTION | MHS-TN-JA063-MMP ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHS | 84 | | PRT 5 | Figure 5.4-1 | 178 |
| MHS | 85 | | PRT Cal 1 118. | Figure 5.4-1 | 178 |
| MHS | 86 | | PRT Cal 2 95.3 | Figure 5.4-1 | 178 |
| MHS | 87 | | PRT Cal 3 80.6 | Figure 5.4-1 | 178 |
| MHS | 88 | | Hk Mode Code | Figure 4.2.2.1-2 | 175,176,178 |
| MHS | 90 | | H1 Mean Ct Odb | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 91 | | H2 Mean Ct Odb | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 92 | | H3 Mean Ct Odb | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 93 | | H4 Mean Ct Odb | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 94 | | H5 Mean Ct Odb | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 95 | | H1 Mean Counts | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 96 | | H2 Mean Counts | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 97 | | H3 Mean Counts | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 98 | | H4 Mean Counts | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 99 | | H5 Mean Counts | Figure 4.3.2.1.7(mean of pos 1-90) | 179 |
| MHS | 102 | | Profile Number Pro0 | Figure 4.3.2.3 | 176 |
| MHS | 103 | | Ch/H1 Dc Os Wd | Figure 4.3.2.1-3 | 178,179 |
| MHS | 104 | | Ch/H2 Dc Os Wd | Figure 4.3.2.1-3 | 178,179 |
| MHS | 105 | | Ch/H3 Dc Os Wd | Figure 4.3.2.1-3 | 178,179 |
| MHS | 106 | | Ch/H4 Dc Os Wd | Figure 4.3.2.1-3 | 178,179 |
| MHS | 107 | | Ch/H5 Dc Os Wd | Figure 4.3.2.1-3 | 178,179 |
| MHS | 113 | | Spe Mux Code | Figure 4.3.2.1-3 | 175 |
| MHS | 114 | | H1 Gain | Figure 4.3.2.1-3 | 186 |
| MHS | 115 | | H2 Gain | Figure 4.3.2.1-3 | 186 |
| MHS | 116 | | H3 Gain | Figure 4.3.2.1-3 | 186 |
| MHS | 117 | | H4 Gain | Figure 4.3.2.1-3 | 186 |
| MHS | 118 | | H5 Gain | Figure 4.3.2.1-3 | 186 |
| MHS | 119 | | Ch1 Rqrd DC Off | NAGE Calculated Value | 179 |
| MHS | 120 | | Ch2 Rqrd DC Off | NAGE Calculated Value | 179 |
| MHS | 121 | | Ch3 Rqrd DC Off | NAGE Calculated Value | 179 |
| MHS | 122 | | Ch4 Rqrd DC Off | NAGE Calculated Value | 179 |
| MHS | 123 | | Ch5 Rqrd DC Of | NAGE Calculated Value | 179 |
| MHS | 125 | | Ea Pos 1 Mpp | Figure 4.3.2.1-7 | 186 |
| MHS | 126 | | Ea1 H1 Ch Data | Figure 4.3.2.1-7 | 186 |
| MHS | 127 | | Ea1 H2 Ch Data | Figure 4.3.2.1-7 | 186 |
| MHS | 128 | | Ea1 H3 Ch Data | Figure 4.3.2.1-7 | 186 |
| MHS | 129 | | Ea1 H4 Ch Data | Figure 4.3.2.1-7 | 186 |
| MHS | 130 | | Ea1 H5 Ch Data | Figure 4.3.2.1-7 | 186 |
| MHS | 665 | | Sp Pos 1 Mpp | Figure 4.3.2.1-7 | |
| MHS | 666 | | Sp1 H1 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 667 | | Sp1 H2 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 668 | | Sp1 H3 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 669 | | Sp1 H4 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 670 | | Sp1 H5 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 671 | | Sp Pos 2 Mpp | Figure 4.3.2.1-7 | |
| MHS | 672 | | Sp2 H1 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 673 | | Sp2 H2 Ch Data | Figure 4.3.2.1-7 | |

| TLM ID | | | DESCRIPTION | MHS-TN-JA063-MMP ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHS | 674 | | Sp2 H3 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 675 | | Sp2 H4 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 676 | | Sp2 H5 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 677 | | Sp Pos 3 Mpp | Figure 4.3.2.1-7 | |
| MHS | 678 | | Sp3 H1 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 679 | | Sp3 H2 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 680 | | Sp3 H3 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 681 | | Sp3 H4 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 682 | | Sp3 H5 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 683 | | Sp Pos 4 Mpp | Figure 4.3.2.1-7 | |
| MHS | 684 | | Sp4 H1 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 685 | | Sp4 H2 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 686 | | Sp4 H3 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 687 | | Sp4 H4 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 688 | | Sp4 H5 Ch Data | Figure 4.3.2.1-7 | |
| MHS | 689 | | Ob Cal Tg1 Mpp | Figure 4.3.2.1-7 | |
| MHS | 690 | | Ob Cal Tg1 H1d | Figure 4.3.2.1-7 | |
| MHS | 691 | | Ob Cal Tg1 H2d | Figure 4.3.2.1-7 | |
| MHS | 692 | | Ob Cal Tg1 H3d | Figure 4.3.2.1-7 | |
| MHS | 693 | | Ob Cal Tg1 H4d | Figure 4.3.2.1-7 | |
| MHS | 694 | | Ob Cal Tg1 H5d | Figure 4.3.2.1-7 | |
| MHS | 695 | | Ob Cal Tg2 Mpp | Figure 4.3.2.1-7 | |
| MHS | 696 | | Ob Cal Tg2 H1d | Figure 4.3.2.1-7 | |
| MHS | 697 | | Ob Cal Tg2 H2d | Figure 4.3.2.1-7 | |
| MHS | 698 | | Ob Cal Tg2 H3d | Figure 4.3.2.1-7 | |
| MHS | 699 | | Ob Cal Tg2 H4d | Figure 4.3.2.1-7 | |
| MHS | 700 | | Ob Cal Tg2 H5d | Figure 4.3.2.1-7 | |
| MHS | 701 | | Ob Cal Tg3 Mpp | Figure 4.3.2.1-7 | |
| MHS | 702 | | Ob Cal Tg3 H1d | Figure 4.3.2.1-7 | |
| MHS | 703 | | Ob Cal Tg3 H2d | Figure 4.3.2.1-7 | |
| MHS | 704 | | Ob Cal Tg3 H3d | Figure 4.3.2.1-7 | |
| MHS | 705 | | Ob Cal Tg3 H4d | Figure 4.3.2.1-7 | |
| MHS | 706 | | Ob Cal Tg3 H5d | Figure 4.3.2.1-7 | |
| MHS | 707 | | Ob Cal Tg4 Mpp | Figure 4.3.2.1-7 | |
| MHS | 708 | | Ob Cal Tg4 H1d | Figure 4.3.2.1-7 | |
| MHS | 709 | | Ob Cal Tg4 H2d | Figure 4.3.2.1-7 | |
| MHS | 710 | | Ob Cal Tg4 H3d | Figure 4.3.2.1-7 | |
| MHS | 711 | | Ob Cal Tg4 H4d | Figure 4.3.2.1-7 | |
| MHS | 712 | | Ob Cal Tg4 H5d | Figure 4.3.2.1-7 | |
| MHS | 713 | | Sc Packet Checksum | Section 4.1.3 | |
| MHS | 714 | | Mdp St Add Msb | Figure 4.3.2.2-1 | 174 |
| MHS | 715 | | Mdp St Add | Figure 4.3.2.2-1 | 174 |
| MHS | 716 | | Mdp St Add Lsb | Figure 4.3.2.2-1 | 174 |
| MHS | 725 | | Test Id Word | Section 4.3.2.3 | 173,174 |
| MHS | 730 | | Tstid Profile | Section 4.3.2.3 | 173 |
| MHS | 731 | | Tstid Start Bl | Section 4.3.2.3 | 173 |
| MHS | 735 | | Mean Earth Ch1 Counts | Figure 4.3.2.1-7 | 186 |

| TLM ID | | | DESCRIPTION | MHS-TN-JA063-MMP ref. | NAGE PAGE |
|---|---|---|---|---|---|
| MHS | 736 | | Mean Earth Ch2 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 737 | | Mean Earth Ch3 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 738 | | Mean Earth Ch4 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 739 | | Mean Earth Ch5 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 740 | | Mean Space Ch1 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 741 | | Mean Space Ch2 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 742 | | Mean Space Ch3 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 743 | | Mean Space Ch4 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 744 | | Mean Space Ch5 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 745 | | Mean Obct Ch1 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 746 | | Mean Obct Ch2 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 747 | | Mean Obct Ch3 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 748 | | Mean Obct Ch4 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 749 | | Mean Obct Ch5 Counts | Figure 4.3.2.1-7 | 186 |
| MHS | 758 | | Tst S-Add MSB Hex | Section 4.3.2.3 | |
| MHS | 759 | | Tst S Add LSW Hex | Section 4.3.2.3 | |
| MHS | 760 | | Tst E-Add MSB Hex | Section 4.3.2.3 | |
| MHS | 761 | | Tst E-add LSW Hex | Section 4.3.2.3 | |
| MHS | 762 | | Num Errors | Section 4.3.2.3 | |
| MHS | 795 | | Tst Start Addr Hex | Section 4.3.2.3 | |
| MHS | 796 | | Tst End Addr Hex | Section 4.3.2.3 | |
| MHS | 797 | | PRT1 Sampl 120 cnts | Section 4.3.2.3 | |
| MHS | 798 | | PRT2 Sampl 120 cnts | Section 4.3.2.3 | |
| MHS | 799 | | PRT3 Sampl 120 cnts | Section 4.3.2.3 | |
| MHS | 800 | | PRT4 Sampl 120 cnts | Section 4.3.2.3 | |
| MHS | 801 | | PRT5 Sampl 120 cnts | Section 4.3.2.3 | |
| MHS | 802 | | Cal Channel 1 cnts | Section 4.3.2.3 | |
| MHS | 803 | | Cal Channel 2 cnts | Section 4.3.2.3 | |
| MHS | 804 | | Sam 1 Pos Data | Section 4.3.2.3 | |
| MHS | 805 | | Sam 2 Pos Data | Section 4.3.2.3 | |
| MHS | 806 | | Sam 3 Pos Data | Section 4.3.2.3 | |
| MHS | 807 | | Sam 4 Pos Data | Section 4.3.2.3 | |
| MHS | 808 | | Sam 5 Pos Data | Section 4.3.2.3 | |
| MHS | 809 | | Sam 6 Pos Data | Section 4.3.2.3 | |
| MHS | 810 | | Sam 7 Pos Data | Section 4.3.2.3 | |
| MHS | 811 | | Sam 1 CD Data | Section 4.3.2.3 | |
| MHS | 812 | | Sam 2 CD Data | Section 4.3.2.3 | |
| MHS | 813 | | Sam 3 CD Data | Section 4.3.2.3 | |
| MHS | 814 | | Sam 4 CD Data | Section 4.3.2.3 | |
| MHS | 815 | | Sam 5 CD Data | Section 4.3.2.3 | |
| MHS | 816 | | Sam 6 CD Data | Section 4.3.2.3 | |
| MHS | 817 | | Sam 7 CD Data | Section 4.3.2.3 | |
| MHS | 998 | | Coarse Time | Figure 4.1.2-1 | 174 |
| MHS | 999 | | Fine Time | Figure 4.1.2-1 | 174 |
| MHS | 1000 | | MHS LRI Status | N/A - NAGE use only | 174 |